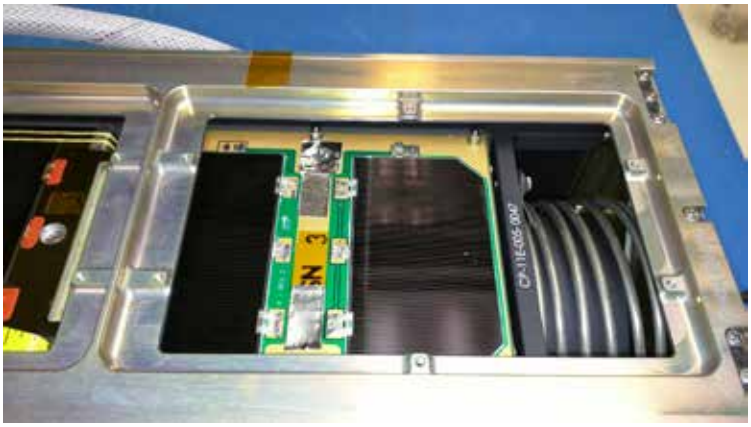
The AMSAT® Journal

Volume 38, Number 5 September/October 2015

in this issue ....



Fox-1A Completed, Tested, Locked & Loaded in P-POD

Countdown to October 8 - Fox-1A Attached to Atlas V Centaur Stage

AMSAT-NA
10605 Concord St., Suite 304
Kensington, MD 20895-2526

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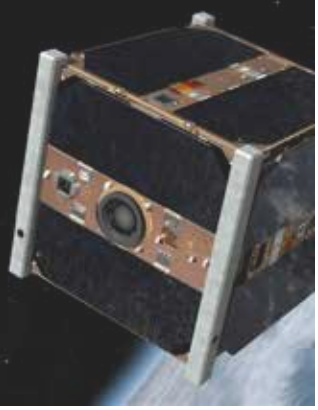
and at additional
mailing offices

Commit to the Future of AMSAT

- **AMSAT has committed to launching Fox-1Cliff and Fox-1D in the 1st quarter of 2016.**
- **We teamed with SpaceFlight, Inc. for integration and launch utilizing SpaceFlight's SHERPA System to sun-synchronous orbit in first quarter of 2016 and we have already paid the launch fee.**
- **AMSAT must now raise the funds to recover those funds to re-establish our reserves.**
- **Along with serving as a "rainy day fund", these reserves provide the "seed money" for future satellite projects.**
- **It takes real dollars to develop real satellites.**
- **As a result, AMSAT has initiated a $125,000.00 campaign to raise the capital needed to provide the resources to maintain our ability to initiate future projects.**

Please consider these donation options

- **Donate to the AMSAT President's Club**
- **Cash gifts with your credit card, PayPal, or check**
- **Gift of life insurance by naming AMSAT as a beneficiary**
- **Gift of stocks or other securities**
- **Bequest to AMSAT in your will or trust**
- **AMSAT is a 501(C)(3) non-profit organization**
- **Call the AMSAT-NA office at 301-822-4376 for questions on any or all of these ways to keep Amateur Radio in space.**



Support AMSAT-NA http://www.amsat.org

AMSAT Announcements

2015 AMSAT Board of Directors Election Results

As a result of the 2015 Board of Directors election, Barry Baines, WD4ASW; Jerry Buxton, N0JY; Drew Glasbrenner, KO4MA; and Bob McGwier, N4HY; will serve on the board for two years.

The First Alternate is Mark Hammond, N8MH and the Second Alternate is Bruce Paige, KK5DO. Both will serve for a term of one year.

The results of the voting with 625 ballots cast are as follows:

Barry Baines, WD4ASW.....475
Jerry Buxton, N0JY.....417
Drew Glasbrenner, KO4MA.....366
Bob McGwier, N4HY.....316
Mark Hammond, N8MH.....289
Bruce Paige, KK5DO.....198
Steve Coy, K8UD.....194
E. Mike McCardel, KC8YLD.....152

Submitted by:

Martha Saragovitz
Manager

Alan Biddle, WA4SCA
Corporate Secretary

AMSAT's Mission

AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and promotes space education. We work in partnership with government, industry, educational institutions and fellow Amateur Radio societies. We encourage technical and scientific innovation, and promote the training and development of skilled satellite and ground system designers and operators.

AMSAT's Vision

Our Vision is to deploy satellite systems with the goal of providing wide-area and continuous coverage. AMSAT will continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other amateur satellite groups.

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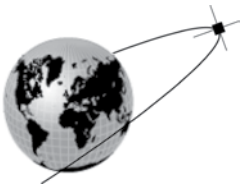
The AMSAT Journal staff is always interested in article submissions. Whenever possible, submissions should be sent via e-mail to journal@amsat.org using plain text or word processor files; photos or figures in TIF, GIF or JPEG formats. Kindly do not embed graphics or photos in your manuscript - we prefer receiving those as separate files. AMSAT-NA reserves the right to select material for *The AMSAT Journal* based on suitability of content and space considerations. The editors of this publication are volunteers giving freely of their talents, time and efforts to produce *The AMSAT Journal*.

by Barry Baines, WD4ASW • wd4asw@amsat.org



I'm writing this column in late September as the temperature starts to cool here in New England, suggesting the onset of a change in seasons. Fall is a very hectic time for many of us, representing both new opportunities upon return from summer vacation and preparing for what might be ahead in our lives.

Fox Program

For AMSAT, this fall represents the "harvesting" of our efforts with the Fox-1 Program, with the scheduled launch of Fox-1A on October 8, 2015 from Vandenberg AFB as part of the ELaNa-XII group of satellites.

In addition, Fox-1Cliff and Fox-1D are now scheduled to fly together under contract with Spaceflight, Inc., which is expected to launch in first quarter 2016. Lastly, RadFXSat/Fox-1B has been assigned a launch that is currently expected to take place in November 2016 from Cape Kennedy as part of ELaNa-XIV.

The next 14 months will be rewarding ones for our volunteers, who spent countless hours designing, documenting, collaborating, fabricating, testing, and integrating our Fox-1 design into flight hardware. There is a significant sense of pride in completing a spacecraft that will be used by amateurs, students, and scientists who will benefit from amateur radio capabilities on board, educational opportunities that our spacecraft can provide to the classroom, and the scientific data that will be available from payloads on board provided by university students and faculty.

Organizationally, AMSAT has benefited tremendously from the Fox-1 program as it provides the basis for training a new generation of satellite builders who are now seasoned veterans capable of tackling more complex and challenging projects. AMSAT's reputation as a satellite innovator is enhanced as the Fox-1 design allows seamless integration of scientific payloads that can benefit from a reliable communications downlink capable of low speed and high-speed data transmissions. Fox-1A will be the first FM repeater satellite in a 1U cubesat form factor, capable of sending low speed telemetry (satellite parameters as well as payload data) while the FM repeater is in normal amateur service. Volunteers have developed ground station software for use by amateurs and others to monitor the health of the satellite and receive and display the data from the scientific payloads that can then be forwarded to a central server. The software will also be capable of handling the imagery that will be made available on Fox-1Cliff and Fox-1D provided by the camera developed by Virginia Tech. The FoxTelem software is available through the AMSAT website.

With the 33rd AMSAT Space Symposium was held on the weekend of October 16 in Dayton, we will presumably know the results of the Fox-1A launch scheduled for the prior week!

Looking Forward

Meanwhile, AMSAT and Virginia Tech are engaged in two different potential payload opportunities that will have significant impact on the Amateur Satellite Service. The first is the Geosynchronous Orbit (GSO) opportunity to place an amateur radio payload on a US Government spacecraft. This will feature a 5 GHz uplink/10 GHz digital downlink signal that will provide up to 100 "channels" for the transmission of digital content, including voice and data. A ground station design will be developed in conjunction with the satellite payload.

AMSAT submitted a "Request for Proposal" (RFP) to Millennium Space Systems (MSS) on September 16, 2015 to conduct the "Payload Accommodation Study" which must be completed in order to determine the feasibility of adding the amateur secondary payload to the host spacecraft before the US Government will agree to allow an amateur payload to be placed on their spacecraft. The study will look at all aspects of placing an amateur payload on this spacecraft, such as the physical placement of the payload on the spacecraft, electrical accommodations including development of a preliminary Interface Control Document (ICD), and determination of technical risk with the addition of this payload to the spacecraft.

AMSAT has agreed to provide $100K in funding to cover the cost for MSS to conduct the Payload Accommodation Study. While AMSAT does have the funds on hand to cover this expense, we do need to raise additional funds to recover this amount in order to have funds available for other potential needs. Please consider a donation to AMSAT to help offset this outlay.

The other project that AMSAT and Virginia Tech are collaborating on is the Phase 3-E Highly Elliptical Orbit opportunity that was announced in July. Virginia Tech under the direction of Bob McGwier, N4HY Director-Research at the Hume Center for National Security and Technology, is in negotiations

continued on page 4 ...

with a US Government agency to fly P3-E as a research satellite with an extensive amateur radio capability. While it appears that there is serious interest in conducting this mission, at this point it is too early to know whether the Government will be in a position to provide the funding to support their research and accommodate their requirements as well as provide the launch direct to HEO.

It does appear that funding to support the development of the amateur radio portion of the spacecraft will fall on the amateur radio community. While P3-E was substantially developed by AMSAT-DL, that development work was essentially halted around 2006. Given the advances in technology since that time and the likely obsolescence of major P3-E subsystems, it is appropriate to evaluate the need to replace what has been built previously with current designs and systems availability. The actual bands to be flown are yet to be determined since it is unclear at this point how much "real estate" will be occupied by the Government's equipment versus amateur radio, along with the associated power budget considerations and other constraints.

AMSAT and Virginia Tech met in Blacksburg, Virginia on October 2-4,to "kickoff" the P3-E project as well as discuss the GSO opportunity. I anticipate that the results of those meetings will be discussed at the AMSAT Space Symposium in Dayton. Having face-to-face meetings will enhance the level of cooperation between the two organizations, define respective roles and responsibilities, create an opportunity to initially define milestones and timelines, and initiate the statements of work. In addition, a discussion of the concepts of operations and look at the two projects from both a technical and satellite user perspective will be important. A key concern for both organizations is to understand the resource requirements of conducting both projects simultaneously and for AMSAT and VT to define how AMSAT engineering volunteers will interact with VT on these projects.

Congratulations to CAMSAT

Congratulations to China-AMSAT (CAMSAT) on the successful launch and deployment of nine amateur satellites on September, 20 , 2015. Six are linear transponder satellites along with a satellite that has both V/U FM repeater and APRS capability. The other two satellites provide downlink telemetry only.

Now comes word from AMSAT-UK's website that a second launch with three amateur radio spacecraft took place late in September with an additional satellite launch in early October. It isn't clear what their capabilities will be. Presumably this information will become available upon successful launches. Needless-to-say, the sudden influx of these amateur satellites opens up new opportunities for amateurs around the world to "work the satellites".

Changing of the Guard

With the counting of the ballots completed on September 15, 2015, the BoD election results were announced by Corporate Secretary Alan Biddle, WA4SCA . Congratulations to the four individuals elected to the Board for a two-year term:

- Barry Baines, WD4ASW
- Jerry Buxton, N0JY
- Drew Glasbrenner, KO4MA
- Bob McGwier, N4HY

The "new" board members are Drew and Bob. However, both have served on the Board in previous years and Drew was also First Alternate in 2015; they are familiar with the nature of the Board's activities and operation. Having experienced individuals coming on board certainly hastens the transition process and we welcome their participation as voting members.

The two alternates (who are designated for a one-year term) are Mark Hammond, N8MH (First Alternate) and Bruce Paige, KK5DO (Second Alternate). Both individuals have served on the Board previously. Having experienced individuals in position to assume voting status if needed is certainly a plus.

A total of 621 ballots were cast, representing 21% of the membership. My thanks to those that submitted their ballots; participation in the Board election process is one of the benefits (and obligation) for AMSAT members. Your participation helps set the direction of AMSAT through the Board candidates that you elect.

The new Board was seated immediately upon election.

Alan Biddle, WA4SCA

With this election, we also bid farewell to Alan Biddle, WA4SCA who did not run for re-election as a board member. Alan is also retiring as Corporate Secretary at the end of September. Alan's impact on AMSAT has been substantial, serving on the Board as well as handling the duties of Corporate Secretary since 2009. Over the past six years as a member of the Senior Leadership Team, Alan's impact has been considerable, not only in managing the responsibilities of Corporate Secretary (including management of the Board Election process as well as keeping minutes of Board Meetings), but handling a variety of 'ad hoc' situations that required attention to detail and a measure of discretion in how best to deal with these issues. Alan's willingness to recognize a need and fill it resulted in his handling a variety of tasks ranging from helping to guide our efforts at Dayton, assisting with planning for the AMSAT Space Symposiums, to serving as an interface with our IT team when the AMSAT website was hacked in February 2013 and managing the AMSAT Store. He was involved with the Fox-1 program and conducted radiation analysis work. He maintained relationships with Vanderbilt University's Institute for Space and Defense Electronics (ISDE), resulting in ISDE's desire to place experiments on Fox-1A and Fox-1C and serving as the lead organization in the submission of proposals under the Cubesat Launch Initiative for RadFXSat/Fox-1B.

Alan served as a "sounding board" for me as I sought advice and counsel on how to deal with a variety of issues facing AMSAT as well as dealing with personalities and "political" issues with other organizations or internal to AMSAT. Alan's insight was always "on target." With his professional background as an Air Force Officer and pilot, a Ph.D. in Physics who once worked at NASA, and commercial airline pilot, he's seen much in his professional career in dealing with organizations, project management, and individuals. Alan could always be counted upon to provide "straight talk" that was always meant to provide honest and thoughtful evaluation of a given situation and to encourage positive and appropriate action. His outlook was always straightforward.

Alan's wise counsel and insight have been invaluable to AMSAT and to me as President. We will certainly miss Alan's considerable talents, sense of humor and dedication to the organization. We wish him well as he moves onto another stage of his life, or in the tradition of the US Navy (I once served as a Surface Warfare Officer), "May Alan have fair winds and following seas". Perhaps now he'll have time to work the variety of new amateur satellites that are now coming into service.

Fox-1C Named Fox-1Cliff

Cliff Buttschardt, K7RR (SK)

Long time Project OSCAR and AMSAT member Cliff Buttschardt, K7RR, passed away on July 30, 2006 at age 75. Project OSCAR awarded Cliff their Lifetime Achievement Award (their highest honor) to him just days before his passing for his contributions to amateur radio.

Cliff served as an advisor/mentor to students building cubesats at Cal Poly. Cliff also served as an Area Coordinator as part of the AMSAT Field Operations Team.

Cliff's wife, Mable Vierthaler passed away in 2013. Both AMSAT and ARRL were notified that they were designated as beneficiaries of the Trust that they had established. Both organizations received similar amounts from the Trust, with AMSAT receiving the initial distribution in mid-July. The initial distribution to AMSAT was around $270,000.00.

Given Cliff's interest in cubesats, the consensus of the Board is to change the designation of Fox-1C ("Charlie") to "Fox-1C ("Cliff") and to have the voice identification of the satellite utilize the new designation. Veronica Monteiro, the "voice" of Fox-1A and daughter of former AMSAT VP-Engineering Tony Monteiro, AA2TX (SK) recorded a voice identification announcement for the satellite, "Hi. This is amateur radio satellite Fox-1 Cliff".

When Fox-1 Cliff is placed in orbit, it will be a fitting recognition of an avid AMSAT member and generous husband and wife team who took steps to help provide the resources to keep AMSAT moving forward. AMSAT is humbled by Cliff and Mable's generosity.

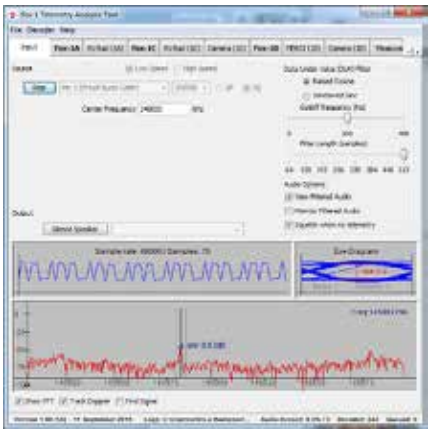
FoxTelem V1.0 Fox-1 Telemetry Decode Software Available

Version 1.0 of the FoxTelem software, the Fox Telemetry Decoder is being released to enable setup, testing, and debugging of your Fox-1A ground station prior to the launch of the satellite. FoxTelem is used to demodulate, store and analyze telemetry data from AMSAT's Fox series of Cube Sats.

Fox-1 satellites include two telemetry formats:

- Slow Speed, also called Data Under Voice (DUV) is 200 bps FSK data sent at the same time as the transponder audio. Whenever the transmitter is on, data is being sent. This happens during beacons and during live QSOs.
- High Speed is 9600 bps FSK sent instead of the transponder. This is used for data intensive experiments such as the Virginia Tech Camera. This is only active when commanded from the ground.

FoxTelem will receive and store both formats assuming you can feed it audio that does not have the frequencies below 200 Hz filtered. For High Speed, the audio must also extend to include the full 9600 bps bandwidth of the FM signal. For both modes this is best achieved from a Software Defined Radio or from the 9600 bps packet port of some radios. The FoxTelem User Guide provides more details.



FoxTelem IQ screen

FoxTelem is supplied as an archive file (.zip on windows, .dmg file on MacOs, .gzip on Linux).

Until Fox-1A is launched you can confirm everything is working by testing with test wav file which will be available from:

http://amsat.us/FoxTelem/recordings .

The FoxTelem page can be accessed from the main AMSAT web page:

http://www.amsat.org --> Fox Project --> FoxTelem Software for Windows, Mac, & Linux

Bob Hayes, KB1SWZ, demonstrates a SO-50 pass for Burns Fisher, W2BFJ, Barry Baines, WD4ASW, and other spectators at Boxboro! 2015, the ARRL New England Convention and Hamfest, held in August.

Amateur Radio, AMSAT and STEM events: a great partnership

Tom Schuessler, N5HYP
N5HYP@amsat.org

Bring your love of Amateur Radio in space to the community at large via STEM outreaches in your area

This article describes how AMSAT volunteers as well as, and in cooperation with local amateur radio clubs, have gotten involved with STEM (science, technology, engineering and math) events in the Dallas, Texas area. What is interesting here is that the event coordinator actually approached AMSAT to be involved.

For the last seven years, an increasingly popular family educational event in North Texas has been Moon Day at the Frontiers of Flight Museum at Dallas Love Field. Held the third Saturday of July, it features a growing collection of exhibitors and activities to engage the imagination of young and old alike relating to space and space exploration. The Moon Day concept was originally meant to commemorate the anniversary of the Apollo 11 moon landing but has grown to include the science and adventure to come in astronomy and space exploration. The National Space Society North Texas chapter coordinates the event in conjunction with the museum.

Moon Day 2015 at the Frontiers of Flight museum in Dallas drew 1600 attendees, many of them young people. Photos by Tom General, KE5ICX and Tom Schuessler, N5HYP

Dallas Amateur Radio Club and AMSAT group work side by side at Moon Day 2015

Kenneth Murphy, then president of the NSS-North Texas group, and, now, ongoing event manager of Moon Day, accepted the challenge by the museum to put on the first Moon Day in 2009. Mr. Murphy describes what happened next: "{We} proposed a forward-looking event that celebrates the future of space exploration and shows off the space-related educational resources available in North Texas." Frontiers of Flight embraced the idea and Moon Day was born.

The desire of the event coordinators and the museum is to stimulate curiosity in STEM learning. The event has grown to encompass Girl and Boy Scout activities, teacher workshops, and special events like live amateur radio uplinks with the International Space Station as was accomplished on July 18th, 2015.

According to Bruce Bleakley of the Frontiers of Flight Museum, "Moon Day is now the largest annual celebration of space exploration in the state of Texas—not even Space Center Houston has a regularly scheduled event as large as this." Attendance this year topped 1600.

From the beginning, Kenneth Murphy sought out AMSAT and amateur radio involvement in Moon Day. "I knew about AMSAT by way of my masters degree in space studies from International Space University. We did a study of small satellites and the OSCAR satellites showed up often in the database. I {also} knew that there was amateur radio in North Texas from our involvement with the Sci-Tech Discovery Center up in Frisco. Occasionally, our NSS-NT outreach displays would overlap with volunteer hams running the radios at the museum. It seemed like a natural fit for a space-themed event, especially in the context of trying to highlight the space-related educational resource." He went on to say, "Also, as a Moon guy, I know that y'all do moonbounces, something that I've always wanted to have at Moon Day."

AMSAT volunteers have been involved with Moon Day for several years now, manning displays, doing demonstrations, conducting satellite contacts, describing orbital mechanics, and showing off the fun and lifelong learning aspects of amateur radio in space. Those that devoted their time this year were Bill Byrom (N5BB), Philip Robinson (KB5ASY), Suzanne Robinson (KF5ECX), Chris Brewer (N5GMJ), Tom Schuessler (N5HYP), and David D'Arcay (KF5LKG). Also involved were Keith Pugh

(W5IU) and Harold Reasoner (K5SXK). Keith mentored a successful Amateur Radio on the International Space Station (ARISS) contact for this year's Moon Day with Harold supplying logistics support. Additional support came from members of the Dallas Amateur Radio Club (DARC) including president Tony Mendina (NT5TM), Tom General (KE5ICX), and others for helping out the above AMSAT volunteers as they occupied the table directly adjacent.

As the program for Moon Day has developed; a strong effort has been made to reach out to the Scouting community in general, but especially to Girl Scouts. The Scouts can earn a STEM activity patch by attending a selection of the day's activities and filling out a worksheet with information gained at each activity; AMSAT activities were included in the STEM patch curriculum. E. Mike McCardel KC8YLD, AMSAT VP of Education, had supplied the exhibit with the Fox satellite model which aroused much interest by event visitors. Having a real satellite to hold in their hand was an eye opener for many young people.

Since a few hiccups with the AMSAT portion of the STEM worksheet were encountered, several of those participating intend to help craft a better learning experience for the attendees. With some new satellites on the horizon, both by AMSAT-NA and others, there should be better opportunities next year for contact demonstrations. There is also a desire to recruit someone to help develop "Orbital Mechanics for the Beginner" illustrations and demonstrations so as to bring some of the complicated science down to earth. Additional demonstration hardware that will inspire and incite curiosity in our hobby will also be sought for next year. WA8SME's 'cubesat simulator' might be a perfect fit for this kind of thing.

As mentioned earlier, the Dallas Amateur Radio Club was exhibiting at the table next to AMSAT. DARC has steadily increased its involvement in STEM beyond Moon Day by regularly participating in the biennual science fairs held at the Dallas Community College District's Brookhaven College. Amateur Radio, electronics demonstrations, satellite contacts and more have been a part of their contribution. Boy and Girl Scouts have been the biggest visitor group according to Tom General, KE5ICX of DARC.

Other areas where DARC has expanded its outreach in are those that are not traditionally considered amateur radio. This is done through a series of on-air nets that cover various topics like Hamfixin's, a food lovers

Moon Day 2015 STEM patch along with Girl Scout and Boy Scout patches/badges related to Moon Day events. Next year we will try and get Radio added as well. For Scouting activity information see: http://www.flightmuseum.com/moon-day-2015-scout-badges/

Philip Robinson KB5ASY, helps a young lady earn her STEM patch

Keith Pugh W5IU (left), ARISS Mentor and a young questioner during the ARISS contact

net, a net for active or retired military and Geeknet for all things computer and tech. Another unique net is an astronomy themed net called Skynet. Tom General streams video of the net over the Internet with links and images so even non-hams who are interested can join in. AMSAT activities and the local AMSAT information net held weekly on a different repeater are always promoted along with satellite news.

Perhaps this article will continue to spur discussion started by Mr. McCardel in his excellent "Outreach" article on the AMSAT web site and others on how the satellite community as a group can develop better STEM related programs to the general population. Educational outreach fits tightly with the AMSAT mission statement. Hopefully this will lead to recruiting more interest in amateur radio and specifically amateur radio in space. A challenge for AMSAT members is to pair up with local ham clubs to find and participate in these types of outreaches in your area. Even without an ARISS contact, the community relations and educational impact is invaluable to the future of our hobby.

"Look Ma, I'm holding a satellite in my hands!"

AMSAT Fox Presentation to Dallas Area Ham Clubs

Jonathan Brandenburg, KF5IDY

Jonathan, KF5IDY, is a lifetime member of AMSAT, a lifetime member of ARRL, and an active participant in the Fox-1 engineering team.

(left) Jonathan at K5PRK.

(below) Jonathan (right) with door prize winner Philip, KG5DDZ (left).

Jonathan Brandenburg, KF5IDY, gave presentations to three Dallas area ham clubs in July: the Dallas Amateur Radio Club,W5FC, the Richardson Wireless Klub, K5RWK, and the Plano Amateur Radio Klub, K5PRK. The presentation opened with an announcement of the upcoming launch of Fox-1A. Audience members were excited to hear about the FM transponder and both data modes, high-speed and low-speed, along with a description of the hosted university experiments from Penn State and Vanderbilt University. Participants were active and asked questions about the expected orbit, output power, and how Fox-1A will be stabilized in orbit. Following the details of Fox-1A, Jonathan described the additional launches and experiments in the Fox-1 program line all the way through Fox-1E demonstrating how the Fox-1 line evolves with each launch.

Looking forward, the audience learned of AMSAT's current programs including AMSAT "Skunk Works", the ASCENT opportunities, and the very exciting Millennium geosynchronous payload opportunity. As an immediate call to action, the presentation continued with a list and description of the voice and digital satellites that are available to amateur radio operators today. Finally, a description of the minimum equipment needed to work satellites made it clear there should be no barrier to participating in this exciting facet of the amateur radio.

For visual aids, multiple portable antennas commonly used for satellite operation were brought to the meeting and the audience looked at engineering models of the Fox-1 IHU, receiver, and transmitter. In closing, Jonathan awarded a door prize of the AMSAT publication "Gould Smith's Getting Started With Amateur Satellites 2015" to give the lucky winners a head start in working satellites.

The AMSAT Fox-1A cubesat is loaded aboard the United Launch Alliance Atlas 5 rocket, designated AV-058, ready to share a ride to orbit with a U.S. Government payload currently planned to launch on October 8, 2015 from Vandenberg Air Force Base, California.

In addition to the primary payload, the National Reconnaissance Office NROL-55 flight, the four cubesats which will be launched in NASA's ELaNa-XII mission include:

The ELaNa Cubesats

- This launch will include the first launch of CubeSat from Alaska and a tribal college.

- **ARC (Alaska Research CubeSat)** - University of Alaska Fairbanks -- Fairbanks, Alaska. The Alaska Research CubeSat (ARC) mission is a technology demonstration mission to increase the technology readiness level of the ARC subsystems and to provide NASA relevant data of the launch environment. Beyond validating the basic platform, two critical subsystems will be tested, (i) a novel low-power attitude control and determination system, and (ii) a communication system capable of high bandwidth data transfer. ARC is the first satellite designed, built, tested and operated by engineering and science students from Alaska.

- **BisonSat** - Salish Kootenai College, Pablo, Montana. The BisonSat mission is an Earth Science mission that will demonstrate the acquisition of 100-meter or better resolution visible light imagery of Earth using passive magnetic stabilization from a CubeSat. The science data, 33 km x 33 km color images with a resolution of 130 m, a few of which will be images of the Flathead Indian Reservation in northwest Montana, will be used primarily for engaging tribal college students and tribal communities in NASA's mission. BisonSat is the first CubeSat designed, built, tested, and operated by tribal college students.

- **Fox-1** - AMSAT, The Radio Amateur Satellite Corporation -- Silver Spring, Maryland. The Fox-1 mission is an education mission that will host a two-way FM communications transponder and an experiment payload allowing students to relay messages from Earth

Photo of the ELaNa XII mission patch

AMSAT Fox-1 Challenge Coin Available for Donations at $100 or Higher

A premium collectable is available for qualifying donations to the Fox satellite program. AMSAT has commissioned a unique challenge coin for donors who have contributed at the $100 level or higher. This challenge coin is shaped as an isometric view of a Fox-1 cubesat, complete with details such as the stowed UHF antenna, solar cells, and camera lens viewport. Struck in 3mm thick brass plated with antique silver, and finished in bright enamel, the coin is scaled to be approximately 1:4 scale, or 1 inch along each of the six sides. The reverse has the AMSAT Fox logo.

Donations may be made via the:

- AMSAT website at **http://www.amsat.org**
- FundRazr crowdsourcing app at: **http://fnd.us/c/6pz92**
- AMSAT office at (888) 322-6728

AMSAT's Fox-1A application to the NASA CubeSat Launch Initiative was announced via an AMSAT News Service bulletin during November, 2011.

SB SAT @ AMSAT $ANS-324.06
AMSAT Submits Proposal to NASA for Fox-1 Satellite

AMSAT News Service Bulletin 324.06
From AMSAT HQ SILVER SPRING, MD.
November 20, 2011
To All RADIO AMATEURS
BID: $ANS-324.06

On Monday, Nov. 14, AMSAT submitted a proposal to NASA for their CubeSat Launch Initiative, also known as the "Educational Launch of NanoSat" (ELaNa) program. NASA selects projects that they deem to have merit in support of their strategic and educational goals. Projects that are selected will be able to enter into a collaboration agreement where NASA will cover the integration and launch costs of the satellite.

AMSAT, working with ARRL, highlighted the educational merit of the project including the incorporation of Fox-1 into the ARRL Teacher Institute seminars. ARRL also provided a letter of support for the project that was a key component of our proposal.

The Clay Center for Science and Technology at the Dexter and Southfield schools in Brookline MA, also provided a letter of support that was an important part of our proposal. The Clay Center noted that they use AMSAT satellites such as ARISSat-1 in their educational activities for K-12 students and that they look forward to making use of Fox-1.

The completed proposal, at 159 total pages, required a significant effort that was all done by volunteers. NASA will select from all of the submissions and announce the winning projects by January 30, 2012.

[ANS thanks AMSAT Vice-President of Engineering, Tony Monteiro, AA2TX for the above information]

AMSAT's Fox-1A acceptance into the NASA CubeSat Launch Initiative was announced via an AMSAT News Service bulletin during February, 2012.

AMSAT NEWS SERVICE
ANS-041 Special Bulletin

SB SAT @ AMSAT $ANS-041.01
ANS-041 AMSAT Fox-1 Cubesat Selected for NASA ELaNa Launch Collaboration

AMSAT News Service Bulletin 041.01
From AMSAT HQ SILVER SPRING, MD.
February 10, 2012
To All RADIO AMATEURS
BID: $ANS-041.01

Project ELaNa, NASA's "Educational Launch of NanoSat" managed by the Launch Services Program at the Kennedy Space Center, announced on February 10 that the AMSAT Fox-1 cubesat has been selected to join the program.

NASA will work with AMSAT in a collaborative agreement where NASA will cover the integration and launch costs of satellites deemed to have merit in support of their strategic and educational goals.

AMSAT President Barry Baines, WD4ASW said, "The ELaNa Launch opportunity marks AMSAT's return to space after the conclusion of the successful ARISSat-1/KEDR flight. We need to get the flight Fox-1, along with an operational flight backup satellite, built, integrated, tested, and delivered. Our ability to provide a spacecraft and get it launched is dependent upon the active support of our donors who wish to see Fox-1 fly."

AMSAT Vice-President of Engineering, Tony Monteiro, AA2TX noted this will provide a launch opportunity for AMSAT's next generation of FM repeater satellites with features and operation beyond the experience
of AO-51.

[ANS thanks AMSAT President Barry Baines, WD4ASW, AMSAT Vice-President of Engineering, Tony Monteiro, AA2TX and AMSAT's Project Fox Engineering team for the above information]

to space and back to other students somewhere on the planet requiring only a simple walkie-talkie style radio combined with a small hand-held antenna.

- **LMRST-Sat (Low Mass Radio Science Transponder - Satellite)**; Jet Propulsion Laboratory -- Pasadena, California. The LMRST-Sat mission is a technology demonstration mission to provide a calibration source in Earth orbit to provide an order-of-magnitude improvement in X-Band deep space navigation (DSN) solutions and raise the technology readiness for a developmental model of the X-Band LMRST exciter. It will consist of a prototype X-Band LMRST and support bus electronics for purposes of calibrating the DSN X-Band navigation equipment. Current calibration methods are performed using sources in deep space that are limited by interplanetary media and ground based calibrations are limited by being in the near–field, too close to the ground, or expensive to replicate if airborne.

Some History ... How We Got to Today

Fox-1A was designed to take advantage of large and growing interest in CubeSats. AMSAT developed a strategy to create a family of CubeSats that would be attractive for flying science missions which would enable partnerships with universities and apply for free launches as science missions. This provided a solution for being unable to fly due to exponentially increasing launch costs.

After the science mission, or even during the science mission, the satellite is capable of running its amateur radio transponder. The Fox Engineering Team arrived at a design which enables simultaneous amateur radio and scientific operations. The two operating modes for Fox-1 are:

- **Transponder Mode**, including
  - FM repeater
  - Telemetry/experiment data sent as sub-audible, low-speed FSK simultaneously

- **Data Mode**
  - High-speed data (9600 bps)
  - Science missions with high data/power requirements

Tony Monteiro, AA2TX (SK) led the Fox-1 Engineering Team from inception in 2009

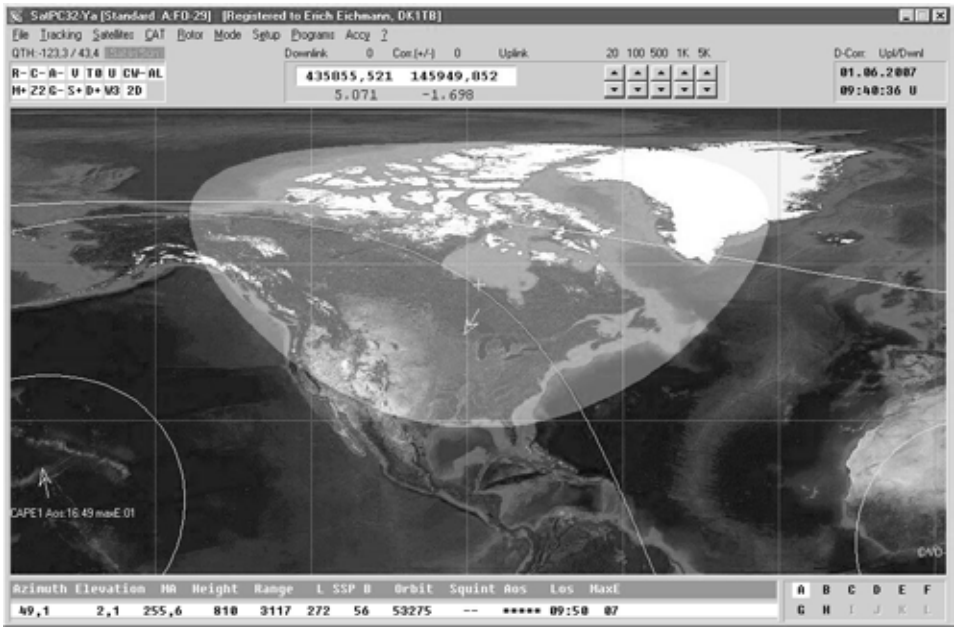
and led AMSAT's efforts to apply for acceptance of Fox-1 in the NASA Education Launch of NanoSat (ELaNa) in 2011 and Fox-1B in 2012. He established relationships with several universities to secure scientific payloads for Fox-1A and Fox-1B, including student experiments. It was Tony that convinced the NASA ELaNa program to modify their qualification criteria to add "not for profits" to those that could apply for launch grants. Universities that were looking for ways to fly their payloads but didn't have the experience to build satellites, were encouraged into collaborations that would benefit both AMSAT and the university.

During Tony's tenure as VP Engineering AMSAT applied for launch opportunities with NASA's Educational Launch of Nanosatellites (ELaNa) as a "not for profit" organization which included collaboration with university projects. AMSAT announced our application in November, 2011. In February, 2012, NASA selected Fox-1A for an ELaNa launch. See the sidebar to the left for a copy of the AMSAT News Service bulletins.

In March, 2014, AMSAT President Barry Baines, WD4ASW appointed Jerry Buxton, N0JY, as AMSAT's VP-Engineering. Jerry had served as the Fox Team Systems Engineer since 2011. Barry noted, "When it became clear that Tony was not likely to recover from his medical issues, I started asking various AMSAT officers and several Fox Team members who should be considered to take the reins of AMSAT Engineering. The only feedback I received was that I should consider Jerry Buxton, N0JY."

The well-dressed Fox-1A operator will want to wear the 2015 AMSAT tee shirt. This year's logo consists of the Fox Satellite logo, and motto YEAR OF THE FOX. See the AMSAT Store at:

http://store.amsat.org/catalog/



Some History: Introducing the Fox-1 Cubesat

The CubeSat concept was originally proposed by Stanford University Professor and AMSAT member Bob Twiggs, KE6QMD. He and Professor Jordi Puig-Suari of Cal Poly collaborated and published the CubeSat Design Specification. Their main purpose was to try to reduce launch costs so that university students could participate in the development and operation of a real, albeit tiny, satellite.

Tony Monteiro, AA2TX, in an article, "AMSAT Fox CubeSat Program Update", published in the July/August 2011 AMSAT Journal wrote, "While AMSAT has pioneered the development of small, low-cost satellites, the CubeSat concept takes this idea even farther (and smaller!). Our AO-51 satellite is a relatively tiny 10-inch cube that weighs less than 25 pounds. A basic CubeSat on the other hand is an even smaller 4-inch cube and weighs less than 3 pounds. AMSAT has adopted the CubeSat idea for our next satellite project to take advantage of the low launch costs. The small size however, does pose some interesting design challenges. The AMSAT Board of Directors approved the Fox satellite project in late 2009, but with ARISSat-1 development still in full swing, it had to be deferred."

Tony continued, "Just a few days after completion of ARISSat-1, the Fox program was started. Several of us met at the 2010 Space Symposium and got together to discuss ideas. Over the next several weeks, these ideas were further developed and finally formalized in a System Requirements Specification document in January of this year [2011]. The spec incorporated many ideas that had never been tried before on a (1-Unit) CubeSat. These included deployable solar panels, an advanced power system, a high-performance processor, a LINUX-based operating system, a software upload capability and a software-defined transponder (SDX) that could support linear and digital modes. Since the battery in AO-51 was known to be having problems, the specifications also included a hardware, analog FM transponder so the Fox satellite could be flown as an eventual replacement for AO-51."

Thermal issues needed to be overcome and were handled by Dick Jansson, KD1K, and Bob Davis, KF4KSS. The Internal Housekeeping Unit (IHU) design was based on the TI OMAP-3 processor, which was developed for use in new smart cell phones.This chip specifically designed for battery power operation. The IHU was to handle control functions and a software defined transponder (SDX) capability. It soon became clear that due to the radiation, error-correcting RAM would be required to make this work. This adds significant complexity to an already challenging design but Bdale Garbee, KB0G, and Keith Packard, KD7SQG, agreed to take on this challenge. In May, 2011 Alan Biddle, WA4SCA also joined the radiation effects analysis team.

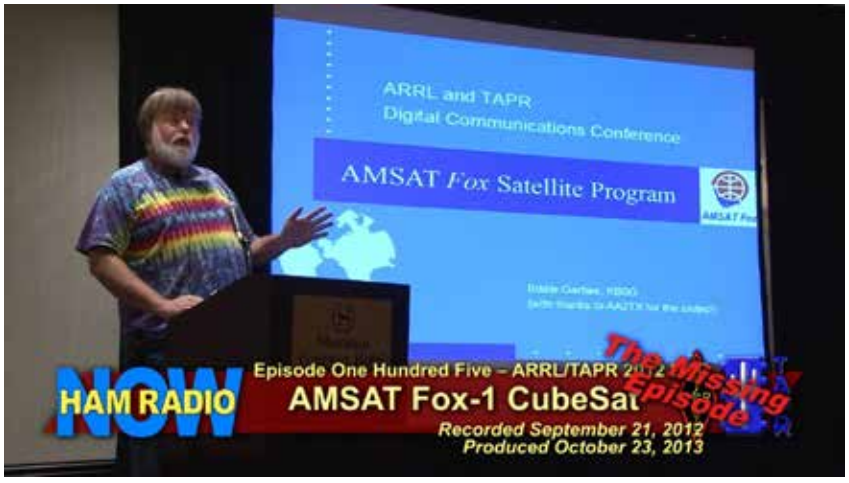
The primary mission of the Fox-1 satellite was to provide a wide-area, Amateur Radio communications capability that can be accessed using very simple ground station equipment such as a handheld FM transceiver paired with a small, handheld beam antenna. This is our intended replacement for AO-51.

Tony wrote,"In our power baseline analysis, we found that we would have enough power to run a basic FM transponder without requiring deployable solar panels. Eliminating the panels significantly simplifies both the mechanical design of the structure as well as the power system electronics."

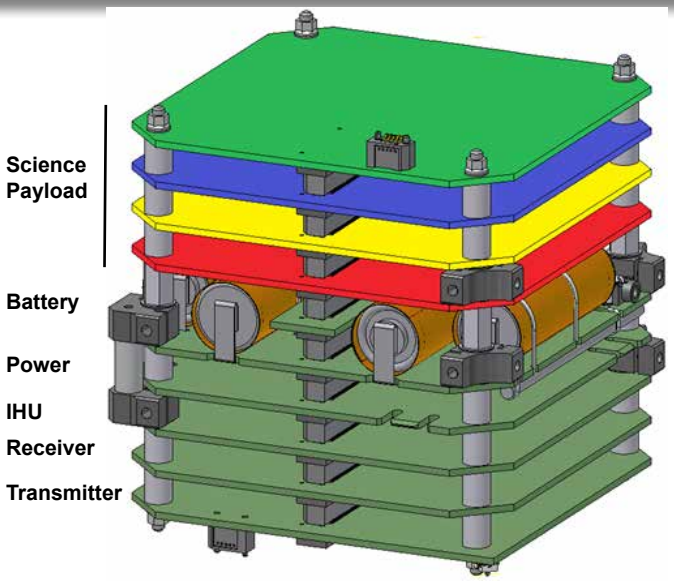
Other key design decisions included:

- To maximize the effectiveness of the power available, Fox-1 will use 2 m for the downlink and 70 cm for the uplink. The lower path loss on 2 m will make the satellite quite a bit easier to receive than if 70 cm were used and the uplink will still be sensitive enough to allow access with only an HT driving a hand-held beam.
- Providing only an FM transponder will allow the use of a high-efficiency, class-C, RF power amplifier and further optimize the use of the limited power available.
- We expect to be able to provide at least 400 mW EIRP on the downlink.

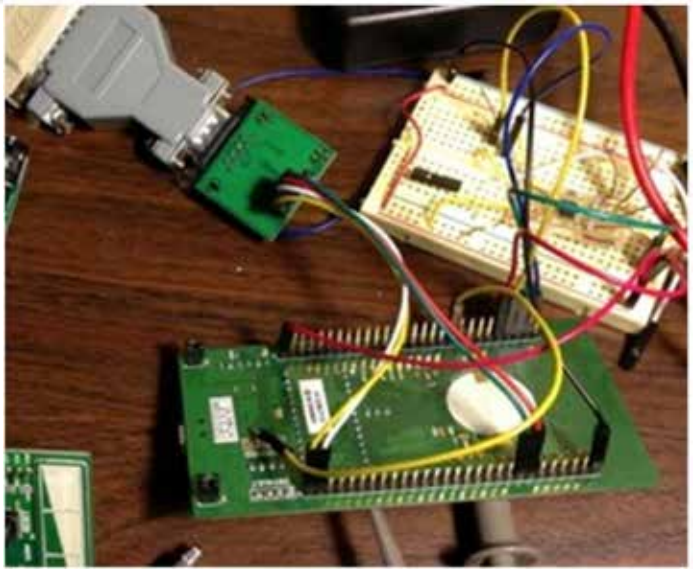
Watch the Fox-1 Status Update, by Tony AA2TX presented at the 2013 Dayton Hamvention
https://www.youtube.com/watch?v=Gub5182mowg



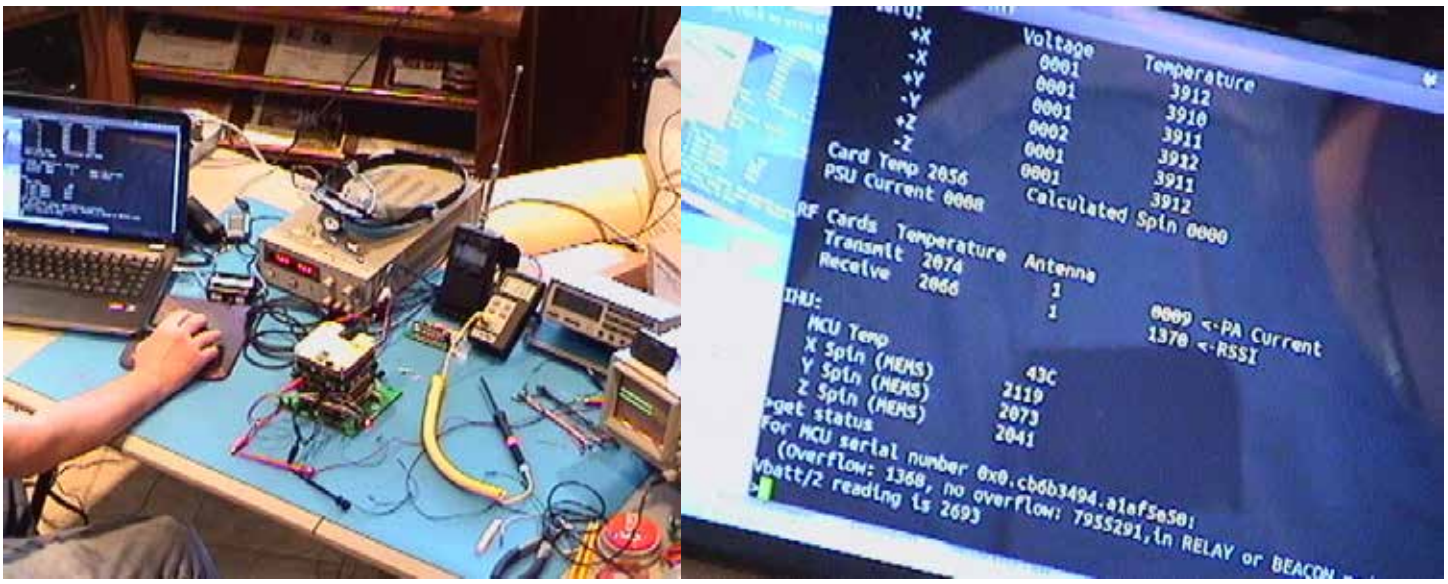
Watch Bdale Garbee, KB0G talk about Fox-1 at the 2012 ARRL/TAPR Digital Communications Conference
https://www.youtube.com/watch?v=14eVqY96uZk



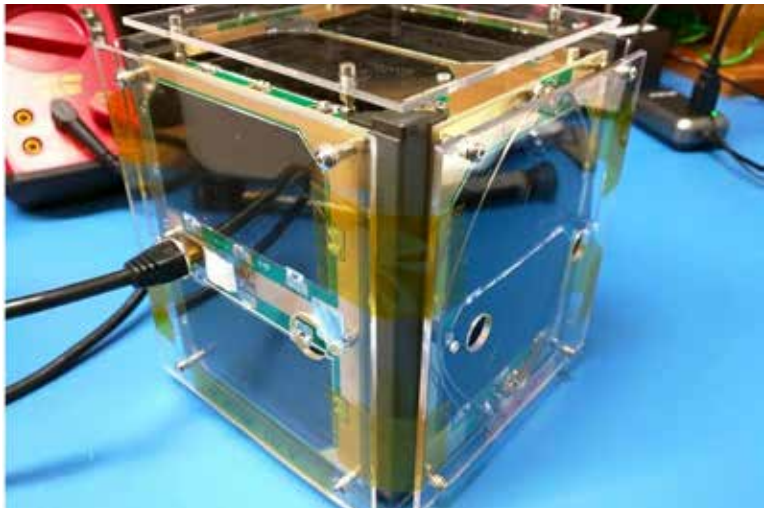
Fox-1 Stack: 400 mW TX downlink on 2M, 70 cm RX, IHU with 32-bit processor, 128K program memory, 16K RAM, 128K MRAM to store telemetry and experiment data.



Board design and prototyping proceeded from rat's nest testing to PC boards to a build up of the Fox-1 stack for the Engineering Prototype.



The Fox Engineering Team developed the ability to do the work in a virtual engineering environment with the team having access to multiple PCs, telephones, GoToMeeting online teleconferencing, and file sharing, and the FoxCam allowing a view into the Fox Labs located in N0JY's shack in Texas.



Fox-1A sporting her final set of solar panel covers ready for the P-POD.

AMSAT Vice President Engineering, Jerry Buxton, N0JY with the Fox-1 model.

Environmental testing was the final step of the actual construction and testing of the Fox-1 flight unit and it took place the week of January 18 in Orlando, FL. Team members Bob Davis KF4KSS (mechanical engineer), Burns Fisher W2BFJ (software engineer) and myself with Fox-1 in tow were all involved in the final measurements, preparations, testing, and post-testing over a 5-day period. It started Tuesday morning in a hotel room where the necessary measurements and steps were performed to put Fox-1 in the TestPOD, a 1U P-POD type device designed for use in the vibration testing. Arriving at the facilities of Qualtest that afternoon we found that another customer was still underway on the vibe table so we spent the afternoon getting to know the Qualtest folks and the facility. Wednesday morning we were back and performed the vibration tests. Fox-1 had to be subjected to vibrations of up to a little over 22G and in all three X, Y, and Z axes in order to satisfy the CubeSat to P-POD ICD requirements that our little CubeSat would not fly apart during launch and harm the primary payload or launch vehicle. The photo shows the brief celebration when Fox-1 passed her Short Function Test and Aliveness Test after that major shakedown!

Once vibe testing was done the Thermal Vacuum Bakeout began on Thursday with a 12 hour pre-soak bringing the temperature to 50° C. at a vacuum of less than 50 milliTorr which is as low as the roughing pump would handle. This was necessary to remove any major contaminants prior to performing the ICD required bakeout to avoid damage to the ion pump, which is used to bring the vacuum chamber pressure down to the level needed for qualification. Fox-1 was not in the Test POD for this procedure. After coasting overnight we began the required bakeout very early Friday morning and brought Fox-1 up to 60° C. and the pressure below $1x10^{-4}$ Torr for six hours to bake out any contaminants in and on the components and structure so that they would not become a problem when Fox-1 hits the vacuum of space. Friday night it was done. We performed the Short Functional Test and Aliveness Test one final time then put Fox-1 "in the bag" to come home with me – an anti-static bag where she will remain except for occasional battery charging until delivery and integration, to keep her "generally clean."

The Fox-1 Mission Readiness Review (MRR) was held February 24 at the SRI facility in San Luis Obispo, CA. With NASA, NRO, SRI, Cal Poly, and Tyvak representing the review board, AMSAT and the four other ELaNa XII satellites each underwent about a two hour review. The purpose of the review is to present the evidence and documentation that shows that each of the requirements of the CubeSat to P-POD ICD (interface control document) are satisfied. These requirements are designed to protect the primary payload, launch vehicle, and other CubeSats on the mission. The flight readiness and operations plan are also reviewed to look at the mission success of the individual satellite, and significant anomalies are reviewed to understand the challenges faced by each team.

NASA requires their ELaNa satellite teams to be on site for the MRR and it is a good opportunity. Being in the same room with your mission sponsors and the launch service provider teams and having the opportunity to ask as well as answer questions makes for a very comfortable and complete review.

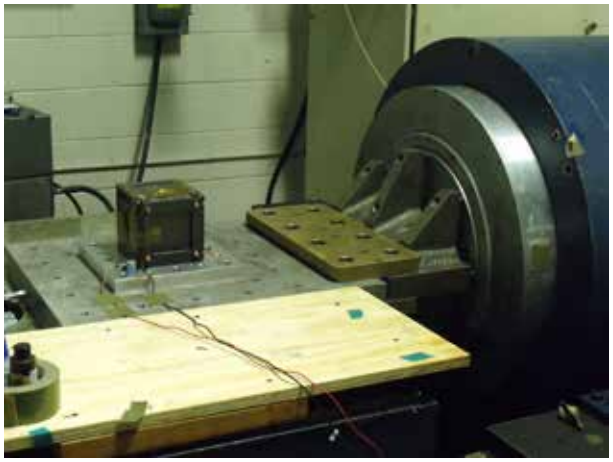
There is no "final outcome" from the review. As the word implies it is an opportunity to go over all of the requirements and each team, as well as the review teams, came away with action items to take care of in order to submit a final review. That will then be passed up the chain to the launch provider so that they can be aware of the status of their "hitchhikers."

The Fox-1 environmental test team: Jerry, NØJY; Bob, KF4KSS; and Burns, W2BFJ, celebrate passing the Short Function Test and Aliveness Test at the conclusion of 3-axis vibration testing with acceleration up to 22 G. The five day test period also included thermal-vacuum testing to very low pressure and high temperature in order to remove any contaminants left over from construction and handling.

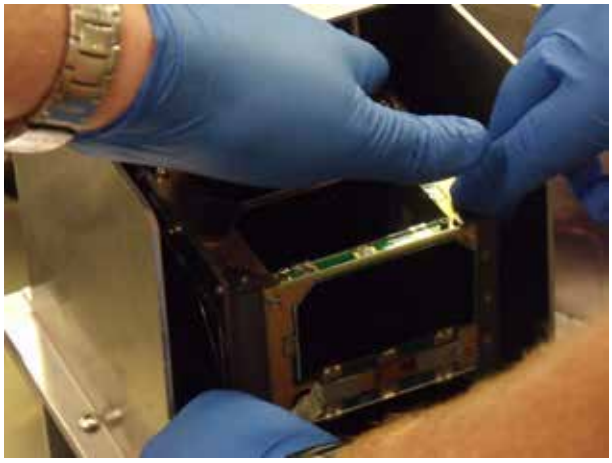
Jerry Buxton, N0JY presenting Fox-1 during the Mission Readiness Review (MRR) which was held February 24 at the SRI facility in San Luis Obispo, CA.

Fox-1A Flight Model Passes Pre-flight Environmental Testing
Ready for Launch!

The Fox-1A Flight Model passed all of its pre-flight environmental testing in Orlando, Florida during the week of January 19. Shown above are the Fox-1A test team (L-R): Bob Davis, KF4KSS; Burns Fisher, W2BFJ; Jerry Buxton, N0JY (not pictured). Also shown are: Lou McFadin, W5DID; Dave Jordan, AA4KN, and Ed Krome, K9EK, who supported the test team.



The Fox-1A Flight Model mounted to the vibration table for the X-axis phase of the 3-axis vibration testing. The test produces high G force vibrations that emulate the expected accelerations that will be experienced during launch.



Fox-1A shown under preparation for thermal-vacuum testing to very low pressure and high temperature in order to remove any contaminants left over from construction and handling.

Fox-1A shown under preparation for thermal-vacuum testing with (L-R) Steve, the Qualtest operator, and Jerry Buxton, N0JY.

Shown monitoring the Fox-1A thermal-vacuum testing are (L-R): Lou McFadin, W5DID; Bob Davis, KF4KSS; Burns Fisher, W2BFJ; and Steve, the Qualtest operator.

Fox-1A has passed all tests and is literally in the bag, ready for launch!

Fox-1A Delivery and Integration

And this is not so much an end but also the beginning of the rest of the Fox-1 Project. Fox-1 delivery and integration took place the week of March 23.

The AMSAT Engineering Team is already busy working on Fox-1Cliff and her flight spare Fox-1D for launch later this year. Fox-1D will be fully tested and ready to step in right up to launch integration should Fox-1Cliff suffer a mishap. And Fox-1D will also be truly "on the shelf" ready for handover on other launch opportunities that are on our radar. That saves AMSAT money not only on the Spaceflight launch of 1Cliff (as standard practice, we have to pay whether we launch a satellite or they launch a mass simulator in our place) but on the testing which can take place for both in one trip, reducing travel expenses. We will then have three fourths of the Fox-1 series done 3Q this year with only Fox-1B "RadFXSat" left to finish for a launch which is tentatively on the calendar for July 2016.

Fox-1A waits for the October 8, 2015 launch. Please remember that the launch is an NRO/OSL classified mission so they're not giving detailed information. It will be likely that Keplerian elements will not be available until just prior to, or perhaps even after, the launch. We will make them available as soon as we are given permission!

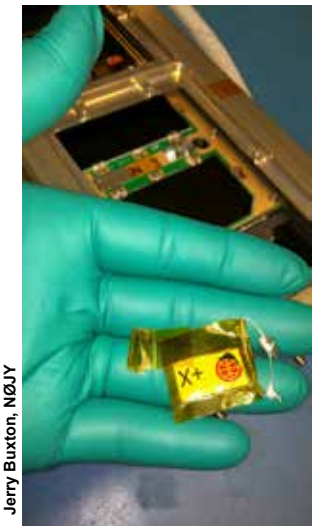

Justin Foley, KI6EPH

On March 25, 2015 AMSAT Vice-President of Engineering, Jerry Buxton, NØJY, reported on the achievement another milestone leading the launch of Fox-1A.

Fox-1A, having passed all integration and environmental testings, and successfully completed a Mission Readiness Review, was delivered by Jerry to the launch integration team at Cal-Poly in San Luis Obispo, California.

Fox-1A was integrated with the P-POD cubesat deployer in preparation for being loaded on the launch vehicle.

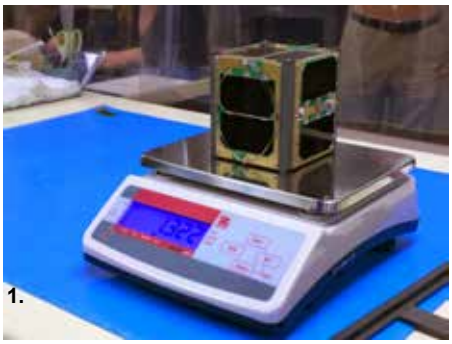

Jerry Buxton, NØJY


Jerry Buxton, NØJY

(left) Fox-1A integrated with the P-POD deployment canister.

(right) The "Remove Before Flight" pin was pulled by Jerry at the completion of his work on system integration and prior to closing all of the side panels on the P-POD.

AMSAT Vice President Engineering, Jerry Buxton, N0JY in clean room gear during Fox-1A integration.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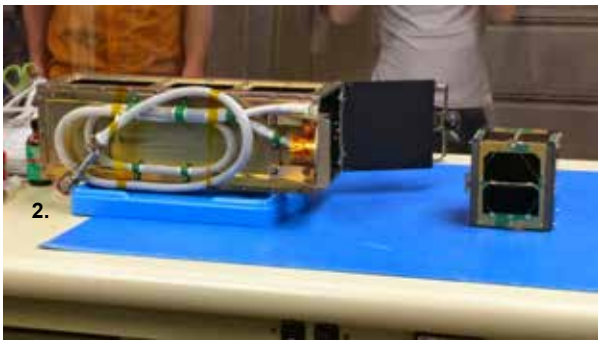
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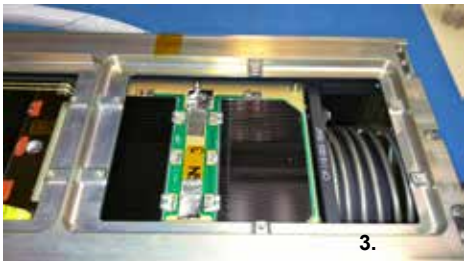
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More photos from the Fox-1A cubesat integration at Cal-Poly in San Luis Obispo, California during the week of March 23, 2015.

Photo 1. Acceptance testing included meeting mechanical specifications such as weight, length, width, height.

Photo 2. Fox-1A ready to be loaded into the P-POD cubesat deployer.

Photo 3. When a control signal releases the trap door on the front of the P-POD the internal spring pushes the cubesats out into space.

Recognizing AMSAT's Fox-1 Team!

Jerry Buxton	N0JY	Program Manager	Keith Packard	KD7SQG	IHU card
Tony Monteiro	AA2TX (SK)	Original driving force	Dan Passaro	AK4PX	Mechanical
Corey Abate	K8SPN	Solar panel design	Ben Pearson	KD7UIY	Systems engineering
Andrew Abken	KN6ZA	Structure machining	Tracie Perez	KF5UYL	PhD student; LED thruster
Joseph Armbruster	KJ4JIO	Assenbly; ground software	Larry Phelps	K4OZS	RF
Bryan Baker	N4DTV	Command and Control RF uplink	Fred Piering	WD9HNU	RF
Jacob Beningo	KD8FAX	Software	David Ping	WB6DP	Antennas
Steve Bible	N7HPR	RF card	Douglas Quagliana	KA2UPW	Ground software
Alan Biddle	WA4SCA	Radiation	Bill Reed	NX5R	Software
Kevin Bishop	KG7NSD	Project Management	Robert Reed		ISDE experiment
Jonathan Brandenburg	KF5IDY	Experiment control software	Chuck Reynerson		Software; Orbital Mechanics
Darell Brehm	WA3OPY	ICM Crystals - RF	Ed Rhodes	WA1LEI	Mechanical construction; AutoCAD
Larry Brown	W7LB	Model program	Brent Salmi	KB1LQD	MPPT
Kevin Burns	KJ4SYL	VT Camera	Bryce Salmi	KB1LQC	MPPT
Steve Christie		Mechanical	Tony Scalpi	N2VAJ	Statek Cyrstals
Bill Clark	KK4EWQ	VT Camera	Jay Schwartz	WB8SBI	Software
Arlen Cordoba		Flight unit structure machining.	Dan Schultz	N8FGV	Test documents and equipment
Don Corrington	AK2S	Power supply; test	Kelley Shaddrick	W0RK	LiIon battery study
Taylor Crisp	KF5SKQ	Mechanical	Brian Sierawski		ISDE software
Bronson Crothers	AA1ZB (SK)	Power Supply	Mark Spencer	WA8SME	ARRL Education Liason
Bob Davis	KF4KSS	Mechanical, Environmental	Kevin Stewart	NF6H	Software
Mitch Davis	WQ3C	VT Camera	Bruce Sutherland	KO4IN	Software
Randy Dawson	KF7CJW	RF	Ron Tassi	N3AEA	Power system
Paul Finch	WB5IDM	RF testing.	Ken Tatebe	KF5IGK	Physics and algorithms
Burns Fisher	W2BFJ	Software team co-lead	Nick Teti		Thermal
Joe Fitzgerald	KM1P	IT support and management	Chris Thompson	AC2CZ	Test documents
Bob Fitzpatrick	KB5SQG	Transponder testing	Al Vasso	KB1UKV	Systems engineering
Marc Franco	N2UO	RF	Marcus Wagnborg	KJ4YTA	Power system
Bdale Garbee	KB0G	IHU and command and control hardware	Brad Walker	KG6MDU	Software
Larry Garvin	KB1QQM	Project management	Kevin Warren	AK4TX	ISDE Radiation Experiment
Braddock Gaskill	W3BCV	IHU card	Damon Wascom	KC5CQW	Test planning; SMD construction
Dan Habecker	W9EQ	RF design and testing	Melanie Wascom	KF5TNK	PCB SMD construction
Mark Hammond	N8MH	STEM Education	Fred Weiser	WQ3M	Software
Alex Harvilchuck	N3NP	University Programs	Dan Welch	W6DFW	Mechanical machining
Bruce Herrick	WW1M	PCB Design	Bob Weller	AK4RO	ISDE
Bryan Hoyer	K7UDM	Battery Card	Aaron Young	KF5SKO	RF
Dick Jansson	KD1K	Thermal	Everett Yost	KB9XI	Batteries
Jim Johns	KA0IQT	Software	Jerry Zdenek	N9YTK	Consultant
Phil Karn	KA9Q	Software	**Fox-1 Advisors**		
John Klingelhoeffer	WB4LNM	RF card	Keith Baker	KB1SF	Project Management
Bryan Klofas	KF6ZEO	Systems engineering	Tom Clark	K3IO	Technical Advisor
Taylor Klotz	K4OTZ	RF	Andrew Glasbrenner	KO4MA	AMSAT VP Operation
Dale Kubichek	N6SJX	Test documents	Chuck Green	N0ADI	Electronic Hardware
Chris Lee	NT6D	RF	Lou McFadin	W5DID	Chief Engineer, ARISS
Zach Leffke	KJ4QLP	VT Camera	Bob McGwier	N4HY	Technical Advisor
Rich Lewis	KG6ZVC	Materials engineer	Stan Wood	WA4NFY	Antennas
Steve Lubbers	KE8FP	Software	**AMSAT's Future in Space**		
Joshua Lynch	KD0OPN	Command software	**What's next? Fox-1Cliff and Fox-1D in the first quarter of 2016 aboard Spaceflight's maiden flight of the SHERPA system on a SpaceX Falcon 9. Additional donor support is needed to offset the costs associated with the launch of Fox-1D in addition to Fox-1Cliff. RadFxSat/ Fox-1B** will fly with the Vanderbilt University radiation experiments expected in 2016. **Fox-1E** "Evolution" will carry a Mode J linear transponder. The transponder is planned to be 30 kHz wide and will also have a 1200 bps BPSK telemetry beacon. Launch opportunities are being developed. **Please visit www.amsat.org to donate support this launch, and help keep amateur radio in space.**		
Gilbert Mackall	N3RZN	Ground software			
Beau Martin		CNC machining			
Mike McCann	KB2GHZ	Software			
Brian McCarthy	N1ZZD	Software			
Norm McSweyn	N3YKF	NiCad Study; SMT assembly			
Dave Mynatt	KA0SWT	Assembly			
Bob Nelson	K2QPN	Power Supply Unit			
Kyle Owen	KK4ANG	RF			

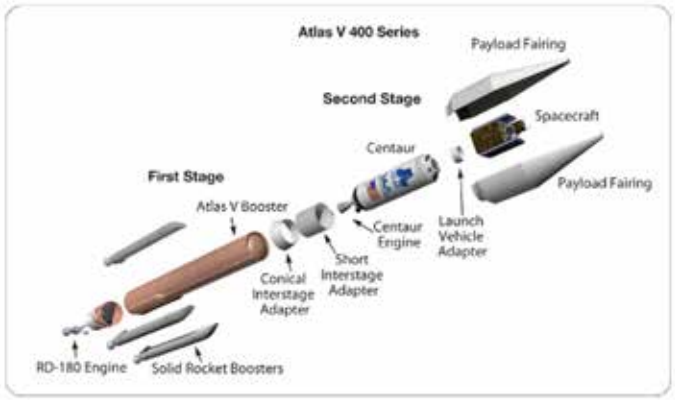
Fox-1A at Vandenberg AFB and Ready for Launch

AMSAT will release the Fox-1A Keplerian elements as soon as the data becomes available. Due to the nature of the primary payload it is expected that detailed elements will not be widely publicized.

The usual case with launches of this nature is that the elements of the sub-payload will be released to the satellite owners. AMSAT will relay the information received.

When multiple cubesats are deployed, as in this launch, several days to weeks may be required to differentiate individual satellites. As the satellites separate in orbit, additional detailed tracking elements will be released.

Monitor amsat-bb, the keps list, Twitter, and Facebook for the latest information.



United Launch Alliance Atlas V 401 configuration incorporates the flight proven 4-m diameter 12.0 m (39.3 ft) large payload fairing (LPF), the 12.9 m (42.3 ft) extended payload fairing (EPF), or the 13.8 m (45.3 ft) extended EPF (XEPF).
Image and description credit: United Launch Alliance
http://www.ulalaunch.com/products_atlasv.aspx

A notable previous launch - AMSAT-OSCAR 7 was launched at 1711 UTC, November 15, 1974 from the Western Test Range at Vandenberg AFB in California. Shown is Jan King, W3GEY.

The P-POD containing Fox-1A and co-passengers have been mated with the Centaur upper stage of the Atlas V in preparation for launch from Vandenberg Air Force Base on October 8.

KG5CCI Sets Distance Records via FO-29 and AO-7 Mode B

Dave Swanson, KG5CCI, of Little Rock, Arkansas, and Christophe Lucas, F4CQA, in Trouy, France, appear to have set a new contact distance record on the FO-29 satellite. The contact occurred on August 27, 2015.

"This was not a scheduled contact," Swanson explained. "I simply answered Christophe's CQ. I knew it was a good contact at the time, but as I was portable up on Arkansas' Shinall Mountain, I did not have the resources available to calculate distances."

Later he realized that the estimated distance between his location in EM34 and Lucas's in JN17 exceeded 7500 km (4650 miles). "About the same time, my e-mail chirped with a message from Christophe, who had come to the same conclusion," Swanson said. After some quick exchanges, and verifying 10-digit locators, the two operators settled on an "official" distance of 7599.959 km (4712 miles).

"To the best of our knowledge, referencing data found on AMSAT-UK's website, this breaks the previous distance records of 7537.799 km between W5CBF and G4DOL, and 7538.685 km between K4FEG and DK1TB," he said.

Then, on September 5, 2015 Dave completed a contact with Manuel EA5TT over a record breaking distance of 7947 km via the OSCAR-7 satellite operating in mode B (432/145 MHz). He reported, "On Saturday, September 5, 2015 at 1812 UTC, I made a scheduled contact with Manuel, EA5TT, using AO-7 Mode B, from the old US Forest Service Fire Tower on top of Rich Mountain in extreme western Arkansas. My 10 digit grid locator was EM24UQ01MU while Manuel is located in IM99SL48CX, in Valencia, Spain. This equates to 7947.381 km which we believe to be a new record for AO-7 Mode B.

Operating Tips When You Operate on Fox-1A

Orbital predictions are needed to tell you when to listen and where to point your antenna. You'll need to tell the web site your location:

- Grid square, or
- Latitude and longitude, or
- If using a computer tracking program, you'll need to load tracking data, called Keplerian elements, into the software. Initially, we'll recommend the web until you have had a chance to learn more.

Your tracking program can now tell you the basic parameters of the satellite pass:

- AOS/LOS - the time of the Acquisition of Satellite (beginning of the pass) and Loss of Satellite (end of the pass).
- Azimuth - this is the compass direction (such as north, south, east, or west) which updates as the satellite flies through your view of the sky.
- Elevation - this is how many degrees above the horizon the satellite will be flying (0° is the horizon and 90° is directly overhead), which updates as the satellite flies through your view of the sky.

Fox-1A Characteristics	
NASA catalog number	TBD post launch
Launch	Atlas 5, NROL-55, Vandenberg AFB, CA
Orbit	LEO (Low Earth Orbit)
Inclination	64°
Eccentricity	0.200
Period	97 minutes
Estimated orbital lifetime	5+ years
Altitude	~470-780 km (~295-490 miles)
Size	10 x 10 x 10 cm (4 inch cube); 1.3 kg (~3 pounds)
Transmit power	400-800 mW
Downlink	145.980 MHz FM voice FSK digital data up to 9600 bps
Uplink	435.180 MHz FM voice 67.0 Hz PL (CTCSS)

Fox-1A Doppler Shift Correction		
	Your Transmit Frequency (with 67 Hz tone)	Your Receive Frequency
AOS (Mem.1)	435.170 MHz	145.980 MHz
Approaching (Mem.2)	435.175 MHz	145.980 MHz
Passing (Mem.3)	435.180 MHz	145.980 MHz
Departing (Mem.4)	435.185 MHz	145.980 MHz
LOS (Mem.5)	435.190 MHz	145.980 MHz

Planned Frequencies for the Fox-1 FM Series Cubesats		
	Uplink FM (67 Hz tone)	Downlink FM
Fox-1A	435.180 MHz	145.980 MHz
RadFxSat Fox-1B *	435.250 MHz	145.960 MHz
Fox-1Cliff*	435.300 MHz / 1267.300 MHz **	145.920 MHz
Fox-1D*	435.350 MHz / 1267.350 MHz **	145.880 MHz

* Pending IARU Coordination, Changes will be announced
** Switchable by command station, not operational simultaneously

Download the Fox-1A Operating Guide from the AMSAT Station and Operating Hints page: http://www.amsat.org/?page_id=2144

Tuning for Doppler Shift

Tune the right frequency. The UV frequency plan used by Fox-1A makes tuning for Doppler shifts no harder than the VU configuration, but it does require some change of technique to decide when to tune. With UV, each station needs to tune their uplink based on their specific location with respect to the satellite. How do you do this?

While the satellite's receiver AFC will help minimize the needed transmission Doppler correction, you must be prepared to make adjustments when using an HT or similar equipment. Some HTs may be set for 2.5 KHz channel spacing, but 5 KHz spacing with the satellite AFC should be adequate. For a typical HT with 5 KHz spacing, the following memory frequencies are suggested:

If Fox-1 is heading directly toward you, the Doppler shift will be greatest, but except for passing overhead, it will change relatively slowly. Passes well to the east or west will have smaller maximum shift, but it will change continuously throughout the pass. Learning to compensate for this is a necessary operator skill. Using the recommended full-duplex operation will allow you to hear if you are tuned on-frequency.

Suggested Fox-1 Basic QSO Tips

A very busy single channel FM satellite is like any FM repeater and you do not call CQ. Exchanges will be crisp and very short, so do not expect to have a lengthy conversation about the weather or your station configuration. Most importantly listening is important: if two other stations are in the middle of the exchange, let them finish. Even though a pass is short, the exchanges are even shorter. You will get a shot so please be patient and respectful of others.

- Listen for others
- Listen for yourself using full-duplex operating technique "W4ABC" (make sure you have your PL switched on!)
- You hear "K9XYZ"
- You say "K9XYZ W4ABC EM74"
- You hear "W4ABC K9XYZ QSL EN52"
- You say "K9XYZ W4ABC QSL 73"
- Please do not call "CQ Satellite" on the FM birds

DopplerPSK: Doppler-Correction Software for NO-84's (PSAT) PSK31 Transponder

Andy Flowers, K0SM/2
aflowers@frontiernet.net

NO-84, also known as ParkinsonSat or "PSAT", is a 1.5U CubeSat project of the students of the United States Naval Academy. Like some other amateur radio transponder projects from the same school, this one sports a 2m AX.25 transponder that may be used for relaying APRS information and spacecraft telemetry. Of particular interest on this satellite, and the focus of this article, is a secondary experimental PSK31 10m (USB) to 70cm (FM) transponder designed by Brno University in the Czech Republic.[1]

The PSK31 transponder has a 3 KHz USB uplink passband near 28.120 MHz and a 435.350 MHz FM downlink. The uplink passband is somewhat small by the standards of most linear transponders, but from the perspective of a PSK31 signal it is quite spacious and could potentially accommodate many simultaneous PSK31 signals. Moreover—because any PSK31 signals on the uplink receiver are relayed as individual subcarriers on the FM downlink—users of the transponder hear in the FM downlink exactly what the satellite hears in its USB receiver. The blessing of this arrangement is that one does not have to battle the Doppler shift that 435 MHz linear downlinks present; one only needs to provide the occasional (and much more forgiving) frequency adjustments just like any other familiar single-channel FM transponder.

Even with the FM downlink, Doppler shift from the USB uplink does present some interesting challenges. As the satellite travels past the transmitter, the frequency from the satellite's perspective will appear to move in accordance with the changes in relative velocity between them. This means that one can still hear the *uplink* Doppler Effect in the FM downlink audio. This results in signals that drift downward in frequency in the FM downlink audio. Figure 1 shows the required uplink Doppler shift correction for high-elevation (67 degrees at zenith) and low-elevation (7 degrees at zenith) passes of NO-84—representative of what one would experience on consecutive passes on a typical day.

This "Doppler-correction problem" is familiar to anyone who operates through linear transponders, but it takes on a life of its own when applied to very narrowband modulation methods like PSK31. Most PSK31 software was designed for HF paths where the largest contributor to frequency drift was the stability of the transmitter and

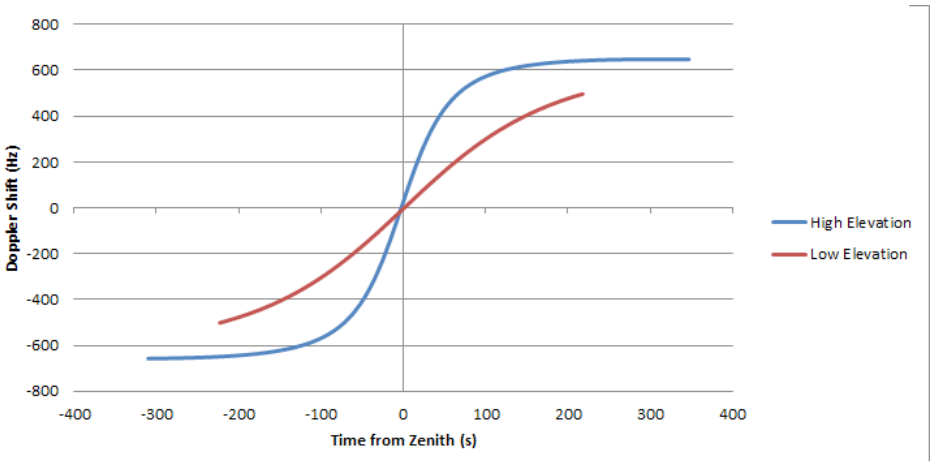


Figure 1: Required uplink Doppler correction on NO-84 for a 67° and 7° pass to hold a signal at constant frequency in the downlink receiver.

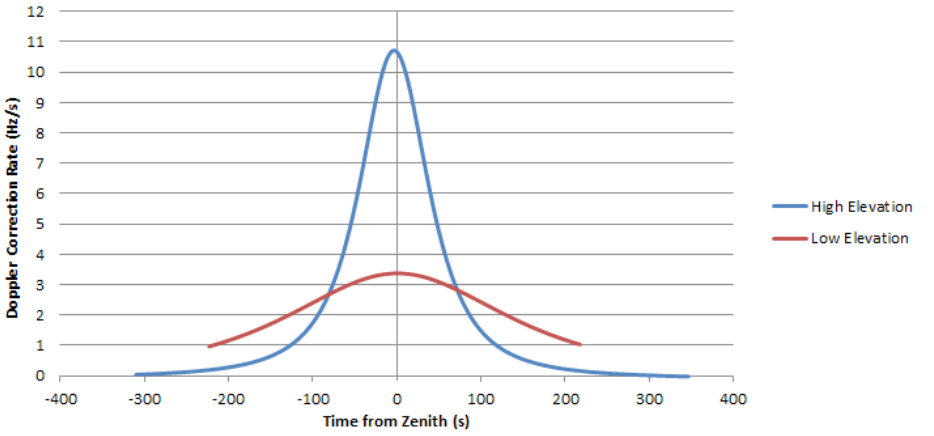


Figure 2: Required Doppler correction rate to hold a signal at a constant frequency in the downlink.

receiver. The designers could reasonably assume that that the AFC would need to tolerate no more than a few Hz per minute with typical amateur equipment. KA3WCA analyzed several popular PSK31 demodulators[2] and found that, indeed, many of them failed to track a signal when the frequency drift is more than 1 Hz/s. The real enemy of sending a very narrowband signal like PSK31 through a satellite transponder is not so much the absolute Doppler shift, but the *Doppler rate*, or how fast the Doppler shift changes over time. This variable is plotted in Figure 2.

This frequency-control problem can be handled in either the transmitter or in the receiver. When NO-84 was first activated, several people tried the conventional approach of controlling the RF frequency of

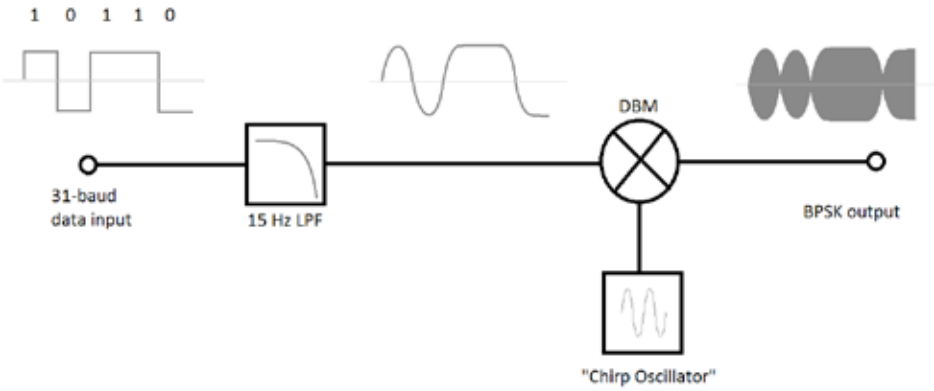


Figure 3: Basic modulation method using in DopplerPSK to provide Doppler correction.

the transmitter (usually through a hardware serial link) to cancel the uplink Doppler shift. While this works well for CW and SSB signals, this approach often does not work as well for PSK31 because of the narrower frequency tolerances and the requirement that the signal must remain phase-continuous. If the stepwise frequency changes are not often enough or do not have enough resolution bit errors will result in the receiver, making the print unintelligible. Peter Martinez (G3PLX) has had some success in correcting for this in the DSP upstream of the RF transmitter, i.e. in the audio that is fed into the SSB transmitter where one has exact control over frequency and phase characteristics.[3] Peter has outlined an ambitious approach that utilizes the full-duplex nature of the transponder. His basic idea is to correct the uplink frequency to hold the downlink frequency constant in the FM receiver--a kind of frequency-locked-loop using your own downlink signal to discipline the transmitter.

DopplerPSK

I took a slightly different approach to the Doppler correction problem; instead of using a feedback loop, I experimented with using the orbital elements themselves to provide the frequency correction. This approach is very much like using software control of the uplink transmitter except that it is done entirely by the software generation of the waveform, upstream from the RF stages. As such, it does not require fine-grained frequency control of the HF transmitter itself, thus simplifying the station in some ways. The goal was to provide enough uplink Doppler compensation to allow existing PSK31 demodulation schemes to function within their tolerances. As long as the residual frequency drift stays on the order of 0.1 Hz/s or less, there should be little SNR penalty when off-the-self PSK31 receiving software is used for receiving. This would allow an operator to make use of existing PSK31 demodulators with other desirable features (like multi-channel decoders) without requiring developers of this software to implement satellite-specific demodulation algorithms.

The result is a transmit-only program that I call *DopplerPSK*. It is little more than a basic PSK31 audio generator whose carrier oscillator is steered by an orbital propagator (perhaps with a Theremin in between). The heart of *DopplerPSK* is a conventional BPSK transmitter utilizing a balanced mixer, but in place of a fixed-frequency carrier oscillator, it uses a "linear chirp" oscillator whose chirp rate is periodically updated by the orbital propagator to match the expected Doppler rate—essentially following the curve in Figure 2. The block diagram of this arrangement is shown in Figure 3. Because the maximum Doppler shift on NO-84's 28 MHz uplink spans no more than a total of 1600 Hz (refer back to Figure 1), it is possible to do this process entirely in software so that it can be fed into a fixed-frequency SSB transmitter with a conventional 3 KHz IF filter. In many ways, operating with *DopplerPSK* is like operating any other PSK31-soundcard software and you can most likely use your existing HF PSK31 configuration if you are so equipped.

The user interface for *DopplerPSK* shows relative satellite position along with the calculated frequency adjustment parameters for your station (see Figure 4). The "TX" button turns the audio source on and off. Operation can be as simple as tuning your transmitter to 28.120 or so, turning on the transmitter, and finding your signal in the passband with your favorite PSK31 receiving software. There are several parameters under the hood that can be adjusted to optimize your particular setup, and the Quick Start Guide explains in greater

continued on page 25 ...

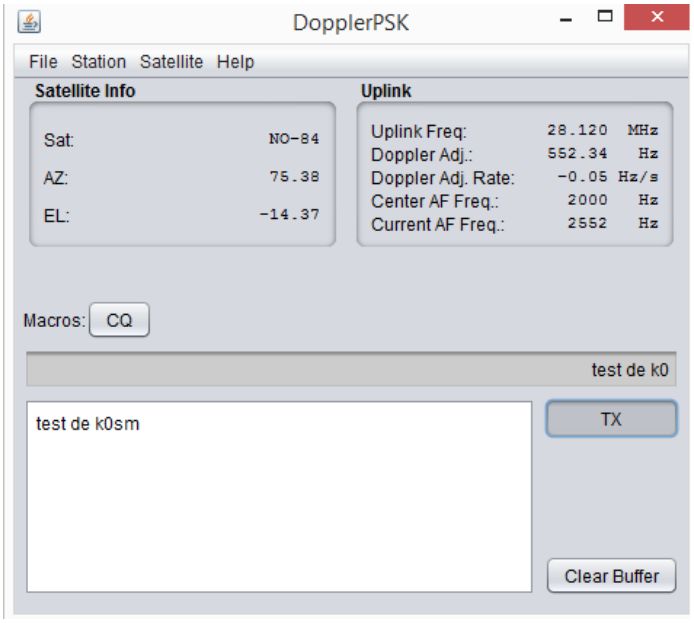


Figure 4: User interface for DopplerPSK

Rotor Controller Box/Boards Available

LVB Tracker Box

- Reasonably priced and all profits go to AMSAT
- Serial interface standard
- USB interface may be easily added by user
- Open software
- Open architecture
- Built-in rotor interface cable with DIN connector
- Power supplied via the rotor controller cable
- Bi-directional interface allows the unit to read the rotor position
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- Front panel manual control
- Self-programmable, allows for easy software upgrades
- Supported by the major tracking programs
- Uses GS-232A or Easycomm I/II protocols

Contact Martha at the AMSAT office 301-822-4376 to order.

The complete units will be built in groups, so get your orders in early. Units will be shipped as they become available.

Minimum donations requested for various configurations:

1) Bare board - $20 + S&H – no parts kits available
2) Custom Enclosure powder coat, silk-screened, drilled/punched - $50 + S&H
3) Complete unit - board, serial output, rotor cable, LCD, enclosure - $200 + S&H **our most popular

Documentation for the LVB Tracker can be found at: http://www.LVBTracker.com

Boards and complete units may be ordered from the AMSAT office at 301-822-4376 or from martha@amsat.org

Visit the AMSAT On-Line Store for details on the updated LVB Tracker Box: http://store.amsat.org/catalog

AMSAT Fox-1Cliff & Fox-1D $125,000 Launch Initiative Goal

AMSAT is excited to announce a launch opportunity for **BOTH** the Fox-1Cliff and Fox-1D Cubesats. In response to a breaking opportunity, AMSAT and Spaceflight, Inc. have arranged for Fox-1D to accompany Fox-1Cliff on the maiden flight of the SHERPA system on a SpaceX Falcon 9 in the 1st quarter of 2016.

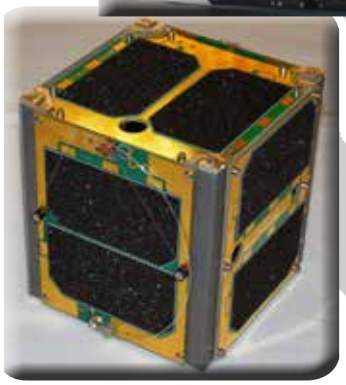
Fox-1Cliff and Fox-1D will provide selectable U/V or L/V repeater capabilities on separate frequencies once in orbit, and will be capable of downlinking Earth images from the Virginia Tech camera experiment.

AMSAT has an immediate need to raise funds to cover both the launch contract and additional materials for construction and testing for Fox-1Cliff and Fox-1D. We have set a fundraising goal of $125,000 to cover these expenses over the next 12 months, and allow us to continue to keep amateur radio in space.

Spaceflight's SHERPA will deploy multiple cubesat payloads on-orbit

Spaceflight's SHERPA System

ISIS QuadPack Nanosatellite Dispenser



Your help is needed to get the AMSAT Fox-1Cliff and Fox-1D 1U Cubesats launched on the Spaceflight's initial SHERPA flight in 1Q 2016.

For the latest news on Fox-1 watch our website at www.amsat.org, follow us on Twitter at "AMSAT", or on Facebook as "The Radio Amateur Satellite Corporation" for continuing news and opportunities for support.

Donations may be made through the AMSAT webpage at www.amsat.org, by calling (888) 322-6728 or by mail to the AMSAT office at 10605 Concord Street, Kensington, MD 20895, USA. Please consider a recurring, club, or corporate donation to maximize our chance of success with this mission.

AMSAT President's Club
Support Fox-1Cliff and Fox-1D

Contribute to AMSAT directly through easy, automatic charges to your credit card. Since AMSAT is a 501(C)(3) organization donations may be USA tax deductible. (Check with your tax advisor.) To join contact Martha at the AMSAT Office by phone (888) 322-6728 in the US, or (301) 822-4376; e-mail martha@amsat.org.

Titanium Donors contribute at least US $400 per month	❒	$400 / month
	❒	$4800 one time
Platinum Donors contribute at least US $200 per month	❒	$200 / month
	❒	$2400 one time
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	❒	$1200 one time
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	❒	$600 one time
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	❒	$300 one time
Core Donors contribute at least US $10 per month	❒	$10 / month
	❒	$120 one time

ARISS-International Meeting Held in Tokyo, Japan

An ARISS International delegates meeting was held at the Big Sight convention facility located in Tokyo, Japan from Thursday August 20 until Sunday August 23. This year's ARISS face-to-face meeting was held in conjunction with the Japan Amateur Radio League's 90th anniversary celebration and international Ham Fair exposition.

ARISS-International face-to-face meetings are periodic gatherings of ARISS Delegates and representatives from the five regions that support the development and operations of the amateur radio systems on board the International Space Station: Canada, Europe, Japan, Russia and the United States.

The meeting covered various facets of the ARISS program, including international teamwork, technical systems development and amateur radio operations on ISS. Included in the meeting agenda were committee reports, technical project updates, upcoming contact events, reports on ARISS activities within the five represented regions and special award recognitions to the JARL, the Japan Aerospace Exploration Agency (JAXA) and JVC Kenwood.

The meeting kicked off with a presentation by Hideshi Kagawa from JAXA on their initiatives to launch and deploy small satellites and technology payloads using their low-cost Epsilon launcher.

Much discussion during the weekend centered around fundraising and the formation of the ARISS-International Sustainability and Funding Committee. Funding projects and recommended yearly budgets were discussed. ARISS Chairman Frank Bauer encouraged all ARISS Regions to begin supporting the development of an international plan and strategy for funding and resources. This will be accomplished through the Sustainability and Funding Committee.

A discussion on a revision of the organization's current Terms of Reference (TOR) was conducted. This new TOR will better formalize and document team roles, responsibilities and processes and will address other more recent changes within the ARISS program. Delegates voted to study the feasibility of creating an interoperable radio system based on the Kenwood D710 radio that would be interchangeable between the Columbus and Russian ISS modules. It was also agreed to continue studying the implementation of an Astro Pi Slide Show and Slide Show module for use in conjunction with the development and operation of the Ham TV system on board the ISS.

During their stay, the group also engaged in other activities such as a ribbon cutting event kicking off the beginning of the JARL Ham Fair and celebrating the 90th Anniversary of the JARL, attending JARL 90th anniversary events, including a Welcome Reception, conducting a very productive Technical Meeting with JVC Kenwood Engineers on the D710/interoperable radio system proposal, and touring JAXA's Tsukuba Space Center and their ISS/Kibo control center.

During the visit, the ARISS-International team took time out to recognize three organizations that have provided sustained support and service to the ARISS program--JARL, for nearly 20 years of ARISS delegation support, JAXA for their sustained support as an ISS space agency, and JVC Kenwood for their leadership in modifying the D700 and D710 radio systems to support ARISS current and future operations. All three organizations received a beautiful, autographed photo montage of the astronauts using ARISS on-board ISS and an ARISS pin and sticker that flew on the last Space Shuttle mission, STS-135.

Before concluding the meeting, ARISS delegates voted to hold its next annual meeting in Houston, Texas in November 2016. This date coincides with the 20th anniversary of the inaugural ARISS working group meeting, held November 1996 at the NASA Johnson Space Center in Houston, Texas.

About ARISS

Amateur Radio on the International Space Station (ARISS) is a cooperative venture of the Radio Amateur Satellite Corporation (AMSAT), the American Radio Relay League (ARRL), the National Aeronautics and Space Administration (NASA) in the United States and other international space agencies and international amateur radio organizations around the world. The primary purpose of ARISS is to organize scheduled contacts via amateur radio between crew members aboard the International Space Station (ISS) and classrooms or informal education venues. With the help of experienced amateur radio volunteers from amateur radio clubs and coordination from the ARISS team, the ISS crew members speak directly with large group audiences in a variety of public forums such as school assemblies, science centers and museums, Scout camporees, jamborees and space camps, where students, teachers, parents, and communities learn about space, space technologies and Amateur Radio.

For more information on ARISS, please go to our web site: http://www.ariss.org. On Facebook: Amateur Radio on the International Space Station (ARISS). On Twitter: ARISS_status

ARISS team photos continued on page 31 ...

... continued from page 21

detail how to accomplish this. There is a rudimentary macro setup for sending preset messages.

The initial tests of *DopplerPSK* were very successful. In the first few days after the initial release, several stations were able to copy their own frequency-stable downlink and some even made a few two-way QSOs through the PSK31 transponder. Figure 5 shows a spectrogram of DK3WN's Doppler-corrected signal along with another uncorrected signal that illustrates the difference that Doppler correction makes.

Because *DopplerPSK* blindly trusts the orbital elements for frequency correction, any error in the system's clock or due to the aging of the orbital elements themselves will manifest itself as a residual drift in the downlink audio. As long as this error stays within the AFC tracking tolerance of the receiving software all will be fine. For practical purposes, a second or two of clock error will be mostly unnoticeable at lower Doppler rates, but one will want the freshest TLE's available and the computer clock to be synchronized with UTC as closely as possible to make the most out of high-elevation passes.

For example, Figure 6 shows a long-term, higher resolution spectrogram that illustrates the residual frequency drift that can be present after applying the correction from *DopplerPSK*. In this recording, KO6TZ is periodically letting the transmitter idle. This effectively creates a 31-Hz "two-tone test" that is very easy to track visually as two lines separated by 31 Hz. In the middle of the pass where the Doppler rate changes the fastest (i.e., where Figure 2 is the steepest) we observe the most residual frequency drift. This drift could be due to any of the above factors, but even at its worst, the residual is no worse than about 0.2 Hz/s—likely within the AFC tolerance of most PSK31 software, but perhaps with some penalty in SNR and the occasional loss of frequency tracking in the longer fades. This suggests that combination of both orbital tracking and the 2nd-order AFC tracking along the lines of what G3PLX has devised may be mutually beneficial for very narrowband digital applications in the presence of the unique challenges that satellites present.

The executable software, along with the quick-start guide and source code is available at the *DopplerPSK* website.

http://www.frontiernet.net/~aflowers/dopplerpsk/dopplerpsk.html

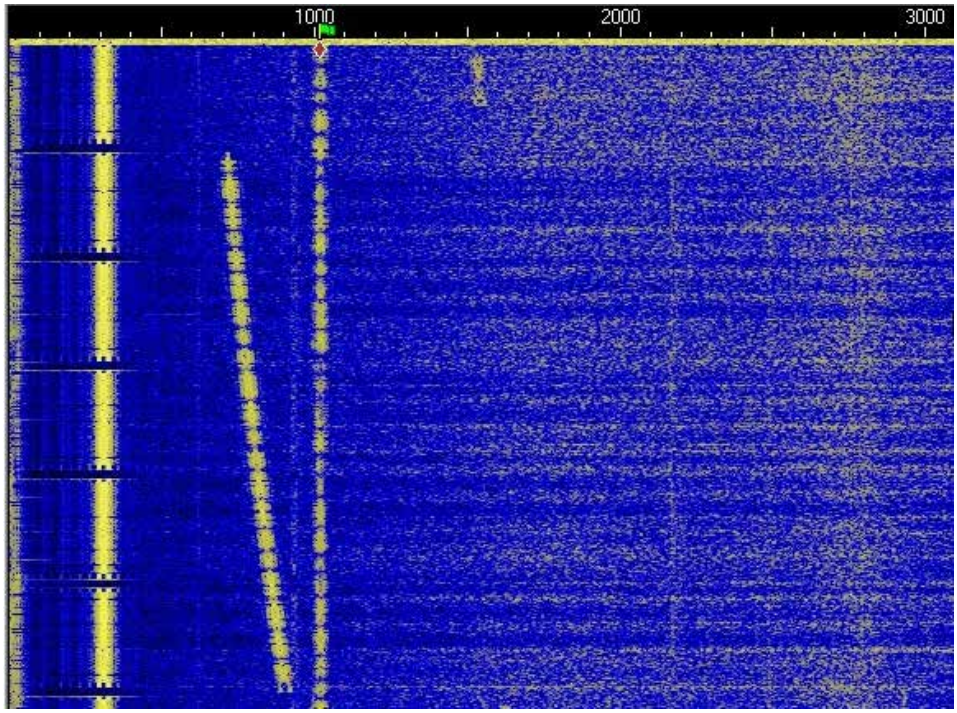

Figure 5: DK3WN's Doppler-corrected signal near 1000Hz alongside an uncorrected signal lower in frequency. Frequency in Hz is shown on the horizontal axis. The strong PSK signal at 315 Hz is NO-84's telemetry beacon. Total timespan is about 2 minutes. (Thanks to Mike Rupprecht, DK3WN, for the image).

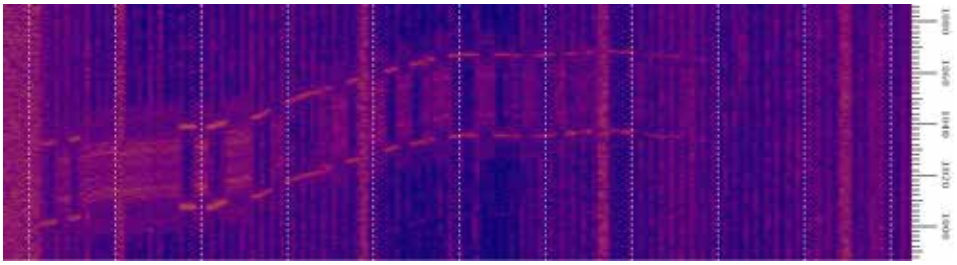

Figure 6: Spectrogram of KO6TZ's signal showing residual frequency drift after applying Doppler correction. Horizontal divisions are 60 seconds, vertical scale is in Hz. (Source recording provided by W0DHB, image acquired using DL4YHF's Spectrum Lab).

The quick-start guide also has a detailed description of the frequency-steering algorithm for anyone who wishes to implement it in their own software—or better yet, improve it. The source code is under a permissive license for the same reason.

References

[1] See http://www.urel.feec.vutbr.cz/esl/files/Projects/PSAT/P%20sat%20transponder%20WEB%20spec02.htm

[2] Bruninga, et al. *PSK31 Transponder Design Page*. Available at http://aprs.org/psk31-project.html (retrieved 15 August 2015).

[3] Martinez, Peter. *The linear-up, FM-down PSK31 transponder*, available at http://aprs.org/PSK31/linearFM-G3PLX.rtf (retrieved 15 August 2015).

Author's note - additional features added to DopplerPSK, now at version 0.20 (September 19, 2015):

- Message loop feature allows UI formatted messages to be sent in a loop. Information added to the Quick Start Guide.
- Modified the Doppler correction updates to once-per-second instead of every 5 seconds. This should improve tracking on very high elevation passes.
- Added ability to select a sound output device separate from system default.
- Bug fixes to improve saving of station information.

Implementation of the International Arms Export Control Act of 1976

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Arizona State University

I am a PhD student at the Consortium for Science Policy and Outcomes at Arizona State University. I'm also Bdale Garbee's daughter and an AMSAT member for longer than I can remember.

As part of a graduate seminar I participated in this year, I did an investigative history and analysis of the implementation of the Arms Export Control Act of 1976, the legislation which created the ITAR. Considering AMSAT's dealings with the ITAR recently, I thought *AMSAT Journal* readers might enjoy and benefit from some explanation as to why those regulations took the form they eventually did. Part 1 of my paper presenting the historical background of ITAR was published in the July/August 2015 issue of *The AMSAT Journal*.This article presents the second part which describes the implementation of ITAR.

Peace Through Superior Firepower[1]

INTRODUCTION

In 2012, the House Foreign Affairs Committee held a hearing on arms and export control reform. Rep. Royce began by stating that "there is bi-partisan consensus that the (regulatory) system is certainly not efficient, that it is the legacy of a different era, and that our economy and national security is suffering as a result of this."[2] While this hearing took place more than thirty years after President Ford signed the Arms Export Control Act (the most comprehensive bill on arms control of its time), this statement would not seem out of place among discussions echoing through the halls of the Capitol during the summer of 1976, when the bill was drafted. In fact, Republican and Democratic lawmakers at the time shared these same sentiments, and encoded those sentiments into the version of the law that made its way to the President's desk.

There are two overarching narratives of public value which frame the evolution of the Arms Export Control Act (AECA): strengthening the economy by maintaining U.S. technical superiority, and bolstering and protecting U.S. national security capabilities and interests. While these two threads run deeply through the decisions made and outcomes observed in the implementation of AECA, they often share the stage with a much broader theme of the fierce competition between the executive and legislative branches over who has the last word in matters of foreign policy. The actors, the set, the audience, and even the script may change – but "national security," "technological superiority," and control over foreign policy continue to run the show. In their piece titled *Implementation as Evolution*, Majone and Wildavsky observe that,

> "the essential constituents of any policy are objectives and resources. In most policies of interest, objectives are characteristically multiple (because we want many things, not just one), conflicting (because we want different things), and vague (because that is how we can agree to proceed without having to agree on exactly what to do)." (Majone and Wildavsky p. 144)

In the act of balancing these three driving narratives, which are at once vague and conflicting, policymakers implemented and interpreted the AECA as it (and they) evolved, resulting in the contemporary version of the bill and its foot soldiers, the International Traffic in Arms Regulations (ITAR). This piece of legislation is a prime example of implementation as fundamentally a "struggle over the realization of ideas" (Majone p. 152), and in this analysis we will focus on the events between 1976 and the present day which serve to highlight the complex roles of the ideas of "national security," "technological superiority," and the tug of war between executive and legislative branch control over foreign policy.

WHAT ARE THE ITAR?

The International Traffic in Arms Regulations (ITAR) control the import and export of "defense-related articles and services" on the United States Munitions List (USML). They implement the provisions of the Arms Export Control Act (AECA) and are described in Title 22 Chapters 120-130, subchapter M of the Code of Federal Regulations (CFR). The Department of State Directorate of Defense Trade Controls (DDTC) interprets and enforces the ITAR, with the express mandate of protecting the interests of U.S. national security and foreign policy objectives.

The ITAR specifies that information, technical data, and materials pertaining to defense and military technologies (items listed on the USML) can only be shared with U.S. persons unless granted special authorization from the DDTC. ITAR does not protect or deal with information related to general scientific, mathematical, or engineering concepts, principles commonly taught in schools, or information in the "public domain." The most stringently controlled items are Significantly Military Equipment (SME) which have "capacity for substantial military utility or capability," most notably tanks, high explosives, naval vessels, missiles, etc, which are noted on the USML with an asterisk. In order to operate within the ITAR while dealing in items on the USML, companies or organizations require an export license (DB-5), a Technical Assistance Agreement (TAA) for exchanging technical emails or other information, and under certain circumstances, a Manufacturing License Agreement (MLA) which allows a foreign country to manufacture a munitions item.

Fundamentally, the ITAR represent the areas of arms and export control that most concern policymakers. Private industry, corporations, and the military interact daily with these regulations, rather than the language of the AECA – this is indeed the case with most federal laws that engender regulations. The ITAR are framed in debates and hearings (such as the 2008 hearing before the Subcommittee on Terrorism, Nonproliferation, and Trade of the Committee of Foreign Affairs) as the primary measures that keep U.S. weapons out of the hands of terrorists:

> "And I think it is important to remember in this respect we are not only talking about weapons going abroad and falling into dangerous hands and then coming back to be used against us. These laws and regulations are also an important means by which we control the transfer of defense articles in the United States to foreign persons and the import, temporary import in particular, of weapon systems from other countries." [3]

1 First used as a slogan from the 1986 science fiction film "Aliens" directed by James Cameron.

2 The full video of Rep. Royce's statement may be found at https://www.youtube.com/watch?v=W1vxJu7gTt4

3 Statement of Mr. Will Lowell, Managing Director, Lowell Defense Trade, LLC. Included in the hearing before the Subcommittee on Terrorism, Nonproliferation, and Trade of the Committee of Foregin Affairs.

The majority of changes made in national arms export policy occur as adjustments to the ITAR or the USML, rather than broad amendments to the AECA. When those do occur, however, they mark major structural shifts in the competing roles of "national security," "technological superiority," and foreign policy. The most striking example of the latter came as a deportation case heard by the Supreme Court that had far reaching consequences for AECA.

INS V CHADA

The case in question concerned a Kenyan East Indian, Jagdish Rai Chada, who in 1975 overstayed his student visa and subsequently successfully appealed to the Immigration and Naturalization Service (INS) for a stay of his deportation. In December of the same year, under the one house veto power section of the Immigration and Naturalization Act (INA), the House vetoed the stay of deportation. Chada then filed suit claiming that the House did not have the power to overrule the INS, a case which made its way to the Supreme Court – by that time, Chada had married an American citizen and fathered a child.

The legislative veto is a legal Congressional action that overrules administrative action. It gained popularity as a legislative device because it simultaneously gave Congress the ability to delegate certain power to the Executive Branch, while maintaining authority to override specific decisions with which it disagreed (Mortsolf p. 3). The case of INS v Chada was the highest profile exercise of the legislative veto since the signing of the AECA. If you will recall, one of the features in the arms export control bill that preceded the AECA, S. 2662, was a legislative veto giving Congress 30 days in which to veto an arms deal. President Ford remarked that this power would make Congress a "virtual co-administrator" of foreign policy, and cited it as one of the reasons he vetoed S. 2662. However, it had incredible staying power with the House and Senate, and while slightly lessened in scope, the legislative veto made its way into the final version of the AECA which the President signed into law.

In the case of INS v Chada, on June 23, 1983, the Supreme Court ruled the legislative veto unconstitutional. This decision was the Supreme Court's most important ruling on the separation of powers since the Watergate era White House tapes, when the litigators were President Nixon and the judicial branch.[4] In the majority opinion authored by Chief Justice Burger, he wrote, "The president's participation in the legislative process was to protect the executive branch from Congress and to protect the whole people from improvident laws … The division of the Congress into two distinctive bodies assures that the legislative power would be exercised only after opportunity for full study and debate in separate settings...."[5] The chief justice elaborated by explaining that the framers of the Constitution outlined four situations in which one house of congress could act alone: the House to initiate impeachments, and the Senate to try impeachments, to confirm or reject presidential appointments, and to ratify or reject treaties. The court decided that the House legislative veto executed against the INS deportation ruling fell under none of these explicit categories. Congress had a mixed response to this ruling. Some welcomed a decision which reinforced their opinion that the legislative veto was unconstitutional; others such as Charles E. Grassley, R-Iowa, a key Senate supporter of the veto, voiced concerns about the ruling's effect on the relationship between the two relevant branches. "We're going to be less willing to delegate in the future," Grassley said.[6]

Of all the laws impacted by this ruling, the legislative veto was most deeply entrenched in the branch power distribution outlined in the War Powers Act and the Arms Export Control Act. The AECA gave Congress a 30 day window during which they could veto any government or private arms sale by concurrent resolution. As amended in 1981, the veto also applied to individual weapons of $14 million dollars or more, and a total sale of $50 million dollars or more. Congress never actually exercised its veto by concurrent resolution, but the spectre of the legislative veto forced Presidents Carter and Reagan to make significant compromises in high profile deals with countries in the Middle East. Despite the Supreme Court finding this particular provision unconstitutional, it is still part of the AECA, the War Powers Act, and more than 200 other current laws. While the teeth have been removed from this feature of the legislation, the legislative veto still exists as an artifact of negotiations between the President and Congress over control of foreign policy issues, debates which still happen on the floor of the House and Senate to this day.

While this protracted game of tug-of-war with respect to the legislative veto took the spotlight in the case of INS v Chada, the narrative of protecting U.S. national security interests through arms export control would once again take center stage just a few years later in a widely televised scandal involving the legally and morally questionable sale of U.S. missiles to Iran. The Iran Contra scandal serves as a public case study not only of arms export control policy in action, but also the role of "national security" in major arms deals.

IRAN CONTRA

Known as the Iran Contra affair, on November 25, 1986, the Reagan administration revealed that it had secretly sold arms to Iran in exchange for American hostages, the profits from which were funneled to American-backed rebels in Nicaragua. President Reagan maintained that he was not personally aware of such a transaction with Iran or Nicaragua. Immediately following the announcement, the Reagan administration formed an investigative committee, following closely on the heels of the House and Senate Foreign Affairs and Intelligence committees. The specific provisions of the AECA under investigation involved selling arms to countries under embargo and the requirement that the President notify Congress of major arms deals.

Reagan authorized the arms sale to Iran on January 17, 1986, 10 full months before reporting that fact to Congress; he placed a gag order on the CIA director at the time (William J. Casey), an order Reagan reportedly later rescinded. This sequence of events was not lost on representatives, some of whom were particularly vocal about their feelings on the matter. "It's one of the dumbest things I've ever heard of," said Rep. Dave McCurdy , D-Okla., a member of the House Armed Services and Intelligence committees. "If Jimmy Carter pulled that stunt, he would have been hung from the rafters."[7]

Also at issue was the standing arms embargo against Iran (in place since 1979) which the

4 pg 3, "Supreme Court Invalidates Legislative Veto." In CQ Almanac 1983, 39th ed., 565-73. Washington, DC: Congressional Quarterly, 1984.
5 pg 4, "Supreme Court Invalidates Legislative Veto." In CQ Almanac 1983, 39th ed., 565-73. Washington, DC: Congressional Quarterly, 1984
6 pg 6, "Supreme Court Invalidates Legislative Veto." In CQ Almanac 1983, 39th ed., 565-73. Washington, DC: Congressional Quarterly, 1984
7 Quote supplied on page 5 of "Special Report: The Iran-Contra Affair." In CQ Almanac 1986, 42nd ed., 415-47. Washington, DC: Congressional Quarterly, 1987

administration appeared to have blatantly violated. However, when questioned about the embargo, White House officials revealed that Reagan had secretly signed an executive order creating exemptions in January of 1986, meaning that the secret arms sales were, in fact, in accordance with the new terms of the embargo. The Attorney General at the time, Edwin Meese III, cleared Reagan by stating that all his actions were legal and proper. Despite that, many legislators and their legal counsel remained convinced that Reagan had violated the spirit, if not the actual letter of the laws regarding selling arms to terrorists or nations under embargo.

The Arms Export Control Act also required the executive branch to notify Congress about all major arms sales made to foreign nations, including commercial and direct government-to-government transactions. The AECA further required the President to make a report at the end of each fiscal quarter to Congress of every sale of $1 million or more, and to give Congress 30 days notice on sales of items worth $14 million or more and total sales of $50 million or more. In a speech made on the floor during deliberation, Rep. John Kerry said:

> "In 1986, section 40 of the Arms Export Control Act was amended to ban the export of items on the U.S. munitions list to any country which the Secretary of State determines repeatedly provides support for acts of international terrorism. A Presidential waiver is included in section 40 based on national interests of the United States. Any time such waiver authority is exercised, the President is required to report to Congress justifying the national interests and describing the proposed export. Two months after enactment of this seemingly straightforward prohibition on exporting arms to terrorist states, 500 TOW missiles were shipped to Iran without notification to Congress. During the Iran/Contra investigation, repeated questions were raised as to the meaning and intent of section 40 and its relationship to other antiterrorism provisions in other laws."[8]

The president could invoke "special authorities" to make such a sale without congressional approval, but was still required to notify Congress that he was doing so and justify the sale in terms of national security interests. Reagan gave no arms sales notices concerning these shipments to Iran, and legal experts continued to try to determine whether or not he was required to have done so in this instance. Congressional response to the incident resulted in legislation in 1987 that required the president to consult with those on Capitol Hill both before and after arms sales to foreign countries, even those involved in secret operations.

It doesn't take much investigation to see the "national security" narrative at play during Iran Contra, both in the funneling of arms sales profits to the Contras in Nicaragua (whom we supported in their efforts to topple their existing Communist regime), and in the reasons given for withholding notice of the missile sale from Congress and the American public. After all, few phrases have such power to erect impenetrable walls of red tape as "national security," a fact of which the Reagan administration took full advantage. As a response to the loopholes and perceived failings discovered during the investigation following Iran Contra, Congress promptly put forward an amendment to the AECA to ensure that those sorts of behaviors in the executive branch could not remain legally ambiguous.

ANTITERRORISM AND ARMS EXPORT AMENDMENTS ACT

In 1989, Congress passed the Antiterrorism and Arms Export Amendments Act, which amended the AECA to prohibit the government or U.S. persons from exporting or selling items on the USML, or financially subsidizing the purchase of munitions by countries or groups deemed "terrorists" by the State Department. The President, under this amendment, has the power to make sales to such a country through recission of the determination made by the Secretary of State, and only with the express permission of Congress. In statements made during floor debate, Senator Kerry said,

> "the involved committees agreed to modify the 'notwithstanding' clause in the new section 4 of the Arms Export Control Act to make clear that application of the ban is limited to 'munitions items controlled pursuant to' the arms control act. This change is intended to ensure that the munitions trade ban that is made total by this act is limited to items specifically controlled as munitions items, not goods and technology that can be legally shipped under the Export Administration Act."[9]

Clearly, this bill was proposed in reaction to the Iran Contra affair, with specific language to disambiguate the legality of interaction concerning sales of munitions between the President and terrorist countries or groups. Never again would constitutional lawyers have to throw up their hands in protest at the ambiguity of this law. The other important provision of this bill is that the President may choose to put an item on the USML by Executive Order, and such a decision is final and not subject to judicial review. The reverse of this power is also true, that the President can remove an item from the USML by the same mechanism.

This very public case study highlights how the branches of government interpret and execute AECA with the national security narrative in center stage. Let us turn now to a more recent and private case study which demonstrates that the need to maintain U.S. technological superiority (perceived or otherwise) is almost as powerful as national security in shaping the implementation of this legislation. This story takes place mainly within the confines of the ITAR and USML, and deals with an amateur satellite organization under fire.

ITAR ON THE GROUND

In a 2008 report prepared for a hearing before the Subcommittee on Terrorism, Nonproliferation, and Trade of the Committee of Foreign Affairs, the GAO stated,

> "First, State and Commerce have yet to clearly determine which department controls the export of certain sensitive items. Jurisdictional disputes are often rooted in the departments' differing interpretations of regulations and inadequate coordination. Second, a lack of clarity on exemption use has limited the government's ability to ensure that unlicensed exports comply with export laws and regulations. These weaknesses compound an already challenged enforcement community, which has difficulty in coordinating investigations, balancing multiple priorities, and leveraging finite resources."[10]

8 Quoted in "Proposal to Reform the Arms Export Control Act." Hearing before the Subcommittee on Arms Control, International Security, and Science of the Committee on Foreign Affairs. House of Representatives, 110th Congress. First Session, March 5, 1987. .

9 See footnote 8 for quote citation

10 Part of the written testimony of the Government Accountability Office (GAO), included in the hearing before the Subcommittee on Terrorism, Nonproliferation, and Trade of the Committee of Foreign Affairs.7 Quote supplied on page 5 of "Special Report: The Iran-Contra Affair." In CQ Almanac 1986, 42nd ed., 415-47. Washington, DC: Congressional Quarterly, 1987

This statement brings to light the main difficulty experienced by private industry, government contractors, universities, and amateur technical organizations in dealing with the ITAR. Not only are the regulations themselves constantly under dispute even within governmental departments, but licensing and enforcement require extraordinary feats of coordination, balancing of priorities, and managing finite resources. These difficulties represent objectives and constraints within the legislation, which necessitate prioritizing, proportioning, and constant adjustment of means and ends (Majone p. 145). Further, "Any change in implementation … changes what the policy does, alters the mix of values, and shifts the relationships among quality, cost, and access" (Majone p. 151). So with these complex and nuanced regulations changing in an effort to adapt to competing objectives, constraints, and results (and confusing even those organizations tasked with their enforcement), what happens when an amateur technical organization runs afoul of the ITAR upon the inclusion of their equipment on the USML? This happened in the past ten years with an organization called AMSAT, whose story is our private case study.

AMSAT AND ITAR

The Radio Amateur Satellite Corporation (AMSAT) was created in the District of Columbia in 1969 as an educational organization. Broadly stated, its goal is to foster Amateur Radio's participation in space research and communication. AMSAT was founded to continue the efforts, begun in 1961, by Project OSCAR, a U.S. based group which built and launched the very first Amateur Radio satellite, OSCAR, on December 12, 1961, four years after the launch of Russia's first Sputnik. Starting with the launch of AO-5 in 1970 through the launch of ARISSat-1 in 2011, AMSAT has been directly involved with 15 amateur radio satellite projects, 14 of which are successfully in orbit.[11]

Prior to 1999, AMSAT had no reason to be aware of ITAR or its various regulatory bodies, because their technology was not on the USML, and therefore not considered a munitions under the jurisdiction of the State Department. However, all of that changed when, after two rocket failures in 1995 and 1996, a congressional investigation found that China received technical data from U.S. satellite manufacturers that built communications payloads lost on those failed flights. China requested the information as part of inquiries into the launch failures, according to a report by a select committee of Congress established to investigate the transfer of technology to China.[12] Concerns over sharing this sensitive technology with a foreign country in the future placed communications satellites on the USML. More than a decade later, the State Department and Department of Defense (DOD) conducted a review and identified certain satellites and related technical components not critical to national security or technologies unique to the United States, which might safely be taken off the USML.

This last criteria highlights one of the core mandates for the maintaining of the USML: ensuring that U.S. technology and related capabilities remain in the hands of American persons, or are transferred under heavy and strict regulation through ITAR. Both legislators and corporate interests agree that this is necessary to ensure that America is able to compete with other nations in the arenas of military technological development and capability. This is especially true in the burgeoning market of space travel, an area to which the U.S. lays both patriotic and technical claim.

On the recommendation of the report issued by the State Department and DOD, in 2013, President Obama executed his authority granted by the Antiterrorism and Arms Export Amendment Act when he issued the executive order to remove communications satellites from the USML.

However, between 1999 and 2013, communications satellites fell under the jurisdiction of the ITAR, a fact of which AMSAT became painfully aware during the development of the P3E satellite with their German partners.[13] In prepared remarks by Bill Ress, AMSAT member and Director of Launch Opportunities, he describes how AMSAT first learned of the ITAR:

> "When it was realized that Amateur satellite development activity could fall under the export control of a document called ITAR … the efforts to support AMSAT-DL (Deutschland) ground to a halt as the AMSAT-NA (North America) volunteers did not want run afoul of ITAR and its often severe penalties. This then started the spread of what I'll call, 'ITAR paranoia' throughout all phases of AMSAT-NA satellite development. Since AMSAT-NA had little or no experience or guidance to offer in ITAR matters, many decided to quit working on AMSAT-DL projects. It became imperative that AMSAT-NA understand these export control rules and provide guidelines for AMSAT-NA members working on our satellites."

Not only were AMSAT's technical goods considered munitions, but also the release of "technical data" to foreign nationals, termed a "deemed export." This can occur simply through emailing data or having a conversation about current AMSAT projects with a foreign national, defined by ITAR as those persons who are not American citizens or who hold a Green Card. Perhaps most importantly, this transfer of data can take place entirely within the United States and still be considered a "deemed export." This restriction can be negotiated by obtaining a State Department approved Technical Assistance Agreement (TAA) between the parties needing to exchange defense item information. The State Department must issue a TAA on a case by case basis, since AMSAT satellites or satellite systems are not well or clearly defined on the USML. Unfortunately for AMSAT's international collaborators, a TAA places the relevant foreign nationals under U.S. jurisdiction, violation of which could subject AMSAT volunteers within organizations like AMSAT-DL to U.S. criminal prosecution.

When AMSAT learned of this, they retained legal counsel and were advised to "Come Clean," voluntarily disclosing all information of possible past ITAR violations to the State Department preemptively. This is a one-time get-out-of-jail free card, and any ITAR violations discovered after the voluntary disclosure will be prosecuted under the fullest extent of the law. In his paper "Lessons Learned," Barry Baines (AMSAT President) describes the result of "coming clean:"

> "DDTC reviewed our submission and the Chief Enforcement Division replied on March 24, 2009 with a single page letter that included the following: 'We reviewed your disclosure and have determined that violations under the International Traffic in Arms Regulations (ITAR) did occur. The

11 A more complete history of AMSAT may be found at http://www.amsat.org .
12 Clark, Stephen. "Obama signs law easing satellite export controls." Spaceflight Now. January 3, 2013
13 A more thorough telling of the story can be found in the prepared remarks of Bill Ress, cited fully in the bibliography

Department views these violations seriously and strongly cautions AMSAT to take necessary and immediate actions to strengthen its compliance process and procedures. We note at this time that we are closing this case without taking action to impose a civil penalty. However, we may reopen the case if it is later determined that the circumstances warrant the initiation of administrative proceedings in accordance with Part 128 of the ITAR. We highly recommend your continued oversight and attention to prevent similar incidents from occurring in the future.' "

Note, however, that no mention is made of *which* of the many documented and disclosed actions were found to be in violations of the ITAR, simply that violations occurred, leaving AMSAT to guess at which actions were in violation and to "try to do better" in the future with no guarantees that they are not repeating past violations. Barry Baines goes further to enumerate the consequences of this ruling:

"Unfortunately, a cornerstone of AMSAT's relationships with other AMSAT organizations for the past 30 years (international satellite development for the benefit of amateur radio worldwide) is no longer encouraged under US law. This inability to cooperate openly on international projects without severe burdens placed on individuals and organizations is a significant loss for amateur radio, and in turn for US science and technology."

While communications satellites are no longer on the USML, most of the components that AMSAT use in their projects still fall under the categories of defense technologies and technical data. Many in AMSAT are hopeful that they will one day be able to collaborate again with their international partners without fear of retribution from the DDTC – however, amateur use of military components are still not labeled as "civil use cases," despite the AMSAT president registering a complaint with the State Department. AMSAT-NA is still doing good work, but participation in projects has dropped significantly because ordinary people are scared of running up against the ITAR.

CONCLUSION

Legislators agree with organizations like AMSAT and private companies that the many and hazardous regulatory hoops they must jump through in order to do their work hamper U.S. technological competitiveness and create a barrier to innovation. In the same hearings referenced previously before the Senate Subcommittee on Terrorism, Nonproliferation, and Trade of the Committee of Foreign Affairs, Will Lowell, Managing Director of Lowell Defense Trade, concluded his prepared remarks by saying, "The solutions (to these regulatory issues) do require a commitment by the Department of State to administer the system provided in the Arms Export Control Act responsibly and effectively. They will also require expanded oversight by Congress, at least in the near term to ensure this is done."[14] This assertion, particularly concerning the desire for more Congressional oversight, demonstrates that the tug of war between the legislative and executive branches continues well into our modern day political climate in matters of national security and technical superiority as protected by the ITAR. Mr. Lowell here proposes that the *implementation* of the Arms Export Control Act has somehow failed, not that it requires re-examination or re-working. The solution, he says, lies in the responsible and effective administration of the law, which itself suggests that attempts to do so thus far have fallen short.

As Majone and Wildavsky remind their readers in *Implementation as Evolution*, there is no such thing as "the objective" when implementing laws such as the Arms Export Control Act. Legislators inevitably and continuously balance competing objectives, time allowed, budgets, procedures, "liberties held invioable," and so on (Majone and Wildavsky p. 145). When lawmakers first drafted the AECA in 1976, they gave clear priority to protecting national security and maintaining U.S. technical superiority – and the final version of the law represented the continual struggle between the legislative and executive branches over who acted as the principal in matters of foreign policy. These three narratives played out through the cases of INS v Chada, the Iran Contra scandal, and how amateur satellite builders navigated the often treacherous terrain of the ITAR. These three cases paint a broader picture of the implementation of the Arms Export Control Act, and give us an idea of what we might expect in the future of this legislation.

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SAREX E-Mail Reflector to be Closed November 1, 2015

At the request of the ARISS US Team, AMSAT-NA Vice President for Human Spaceflight Frank Bauer, KA3HDO has announced that the SAREX reflector will be closed November 1, 2015, and its functions folded into the AMSAT-BB list. Frank explained that at one time operations from the Space Shuttle and the ISS were considered as sufficiently different from other satellite operations as to need separate forums for their respective interest communities. More recently, changes in the human spaceflight operations, the new generation of satellites, and the interests of the general AMSAT community have removed the reasons for this distinction.

If you are subscribed to both SAREX and AMSAT-BB, there is no need to take any action. You will cease to receive new postings on the SAREX list. The SAREX archives will continue to be available for historical purposes. If you are not subscribed to AMSAT-BB and wish to continue to receive human spaceflight announcements, please go to:

http://www.amsat.org/mailman/listinfo

and subscribe to AMSAT-BB.

... continued from page 24 ... ARISS

(left) Attendees posed for a photo at the ARISS-I Face to Face Meeting, August 20 - 23, 2015. Front (L-R): Emanuele D'Andria, Mikio Mouri, Satoshi Yasuda, Francesco De Paolis, Hozumi Ueda, Keigo Komuro. Rear (L-R): Lou McFadin, Ciaran Morgan, Keith Pugh, Mark Steiner, Frank Bauer, Tatiana Kolmykova, Oliver Amend, Sergey Samburov, Ian MacFarquhar, Kenneth Ransom, Rosalie White, Peter Kofler, Stefan Wagener

ARISS Chair, Frank Bauer, KA3HDO, presenting award to JARL President, President Toshihiko Yamanouchi,JA7AIW — in Koto-ku, Tokyo, Japan

Frank Bauer, KA3HDO, of ARISS/AMSAT-NA and Rick Roderick, K5UR, of the ARRL help cut the ribbon opening the Japan Ham fair celebrating the 90th Anniversary of the JARL.

AMSAT is Amateur Radio in Space
... and YOU are AMSAT

Here are opportunities to launch your amateur radio experience to new heights ...

ARISS Development and Support

AMSAT's Human Space Flight Team is looking for volunteers to help with development and support of the ARISS program:

- Mentors for school contacts
- Support for the ARISS web
- Hardware development for spaceflight and ground stations
- Help with QSL and awards certificate mailing.

To volunteer send an e-mail describing your area of expertise to Frank Bauer at: ka3hdo@amsat.org.

AMSAT Internet Presence

AMSAT's information technology team has immediate needs for volunteers to help with development and on-going support of our internet presence:

- Satellite status updating and reporting.
- Add/delete satellites to ANS and the web as needed.
- Research and report satellite details including frequencies, beacons, operating modes.
- Manage AMSAT's Facebook and Twitter presence.

To volunteer send an e-mail to Drew Glasbrenner, KO4MA at: ko4ma@amsat.org.

AMSAT's web presence needs a site content editor and authors for content development for technical articles and feature development.

To volunteer send an e-mail to Alan Biddle, WA4SCA at: wa4sca@amsat.org.

AMSAT Engineering Team

AMSAT Engineering is looking for hams interested in developing ground station equipment for future satellites. An inexpensive L-Band uplink converter is something that is of interest right now for LEO satellites as part of the recently approved technology funding.

If you are interested in helping, please contact AMSAT Engineering by completing the form on the website to tell Jerry Buxton, N0JY, the Vice President of Engineering, how you can volunteer your time and skills to help AMSAT engineering build satellites and other required hardware/software:

http://ww2.amsat.org/?page_id=1121

Please remember to include your AMSAT membership number.

AMSAT User Services

AMSAT is looking for an on-line store co-manager. Your efforts will involve updating and refreshing the osCommerce based AMSAT Store web page when new merchandise becomes available or prices and shipping costs change. Shipping and credit card charges are handled by the AMSAT Office.

- Add new merchandise offerings
- Delete merchandise no longer available
- Update shipping costs as needed
- Add periodic updates for registrations for Dayton and the Symposium
- Interface with the AMSAT Office

To volunteer send an e-mail to JoAnne Maenpaa, K9JKM at: k9jkm@amsat.org

AMSAT Educational Relations Team

AMSAT's Educational Relations Team needs volunteers with a background in education and classroom lesson development ...

- Engage the educational community through presentations of how we can assist teaching about space in the classroom.
- Create scientific and engineering experiments packaged for the classroom.
- Create methods to display and analyze experimental data received from Fox-1.

To volunteer send an e-mail describing your area of expertise to E. Mike McCardel, KC8YLD at: kc8yld@amsat.org.

AMSAT Field Operations

AMSAT's Field Operations Team is looking for satellite operators to promote amateur radio in space with hands-on demonstrations and presentations.

- Promote AMSAT at hamfests
- Setup and operate satellite demonstrations at hamfests.
- Provide presentations at club meetings.
- Show amateur radio in space at Dayton, Pacificon, Orlando Hamcation.

To volunteer send an e-mail to Patrick Stoddard, WD9EWK at: wd9ewk@amsat.org

You can find more information on the web ...
www.amsat.org ... click AMSAT ... then click Volunteer