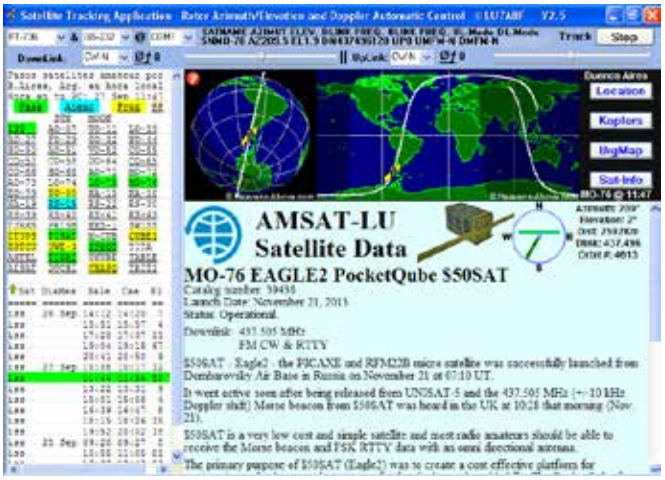
The AMSAT® Journal

Volume 37, Number 6 November/December 2014

in this issue ....

November 15 - 40th Anniversary of AO-7 Launch



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A codicil in your will, naming The Radio Amateur Satellite Corporation as a beneficiary will help insure the continuance of the Amateur Radio Satellite program.

Call the AMSAT-NA office at 301-822-4376 for questions on any or all of these ways you can help build new and exciting satellites.

Support AMSAT-NA

AMSAT Announcements

2014 Officer Elections Announcement

The following Officers of AMSAT-NA for 2014-2015 were elected by the Board of Directors at their annual meeting held in Baltimore, MD.

• President	Barry Baines WD4ASW
• VP Human Space Flight	Frank Bauer KA3HDO
• VP Engineering	Jerry Buxton N0JY
• VP Operations	Drew Glasbrenner KO4MA
• VP User Services	JoAnne Maenpaa K9JKM
• VP Educational Relations	E. Mike McCardel KC8YLD
• Secretary	Alan Biddle WA4SCA
• Treasurer	Keith Baker KB1SF/VA3KSF
• Manager	Martha Saragovitz

The Executive Vice President and VP Marketing positions remain open.

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*.

Happy Holidays! This is a festive time of year and AMSAT extends our best wishes to you during this period of celebration.

AMSAT Space Symposium

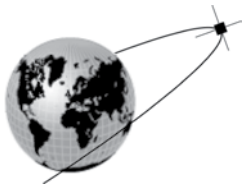
For AMSAT, our "festivities" began at the 2014 AMSAT Space Symposium and Annual Meeting that took place the weekend of October, 10, 2014. This was our opportunity to celebrate the 45th anniversary of AMSAT as well as highlight the 40th anniversary of AO-7. We also had as our banquet speaker Jan King, W3GEY, who led the team that built AO-7.

The AMSAT Annual Meeting was held on Saturday afternoon of Symposium and included participants not at the Symposium through EchoLink.

There isn't space here to go into everything that was covered at the Annual Meeting which consists primarily of a "State of AMSAT" presentation noting significant accomplishments and concerns. I do, however, want to note the continuing decline in AMSAT membership and the impact that has on the overall financial health of the organization.

In my remarks I noted that as of September 2014 we had 2,901 members (life and annual memberships); this is 244 fewer members than in December 2013, a 7.8% decline in 10 months. Since November 2008, we've lost 600 members, a net decline of 17.1%. These drops may be due to a number of factors, including aging membership base that may be dying off, declining interest in satellites, lagging interest in AMSAT, or perhaps a trend by relatively younger amateurs not to join amateur radio organizations. AMSAT is not the only organization that has experienced a membership decline.

The impact of this decline is substantial on AMSAT's financial health, as we traditionally use membership dues to pay for the annual operating expenses of the organization, such as office rent, Martha's salary (no increase in five years), printing of *The AMSAT Journal*, increased postage fees and utilities (phone and Internet). However, the decline in membership means that we're not taking in sufficient income from memberships to cover these expenses. While we do have income from sales of books, software, clothing, etc. that amount does not provide enough additional funding to cover our operating expenses. Consequently, we are forced to either pull funds from our reserves to pay current expenses or use "non-specified" donations to cover operating expenses. This is not a favorable position to be in.



Clearly, we need your help to recruit new members. Talk up AMSAT within your local club(s), encourage people to join AMSAT and highlight the significant good that we've accomplished over the past few years. The most effective recruiting tool for new members is not ads in *QST* or other media, but by word of mouth by those most familiar with the purposes and accomplishments of AMSAT—our active members.

My "AMSAT Status Report" outlining the significant accomplishments of the past year and our goals/expectations for 2015 is available on the AMSAT website.

The Annual Meeting is also an opportunity to recognize our volunteers who have contributed so much of their time and talent on behalf of AMSAT. We recognized 96 individuals for their efforts, ranging from the Fox-1 Engineering Team to ARISS to Field Operations and User Services. Recognition is important and we appreciate their efforts. AMSAT is truly blessed to have such a strong cadre of volunteers doing significant work for AMSAT—we could not accomplish anything without the hard work and dedication of our volunteers. THANK YOU!

We also introduced the AMSAT Challenge Coin to encourage donations to the Fox-1C launch campaign. Details can be found on the AMSAT website as well as this issue of *The AMSAT Journal*. For a $100 or more donation, we will provide you with one of these coins as an expression of your support.

We're working on the date and location of the 2015 AMSAT Space Symposium. We expect to be in position to formally announce next year's event before Christmas. Stay tuned!

The Fox-1 Series of Satellites

The Symposium was also an opportunity to share the latest updates on the Fox-1 program. AMSAT VP-Engineering Jerry Buxton, N0JY, provided attendees with an overview of the state of the program and set up a display showing the Fox-1A engineering model. Attendees could use their personal handi-talkies to listen to the voice IDs as well as transmit through the FM repeater. As we move closer to January, the

continued on page 4 ...

Apogee View - continued from page 3 ...

closer the team is in completing the satellite.

Since the Symposium, AMSAT has formally signed a Services Agreement with Spaceflight, Inc. for launch services to manifest the Fox-1C satellite. I signed the document on October 24, 2014 and AMSAT forwarded the balance of our payment to Spaceflight, Inc. on November 19, 2014 for launch in 3rd Quarter 2015. While we announced a $125,000.00 launch campaign to support this program in July, we have not received donations sufficient to cover the launch costs. In order to make payment to Spaceflight on time, we had to withdraw the funds from our reserves to cover this obligation.

We're now focused on seeking donations to cover this significant milestone. Given the timing of the contract, we realized that we had to make this major financial commitment before we could complete a successful fundraising campaign necessary to make this launch a reality. The AMSAT Board of Directors recognized both the opportunity to fly two CubeSats in 2015 as being an outstanding opportunity to keep amateur radio in space, but also recognized the risk in fulfilling our launch commitment before the launch campaign could be successfully concluded.

Our ability to underwrite future satellite development is contingent upon the generosity of our membership and others to provide the support for this campaign. We will be sending out a year-end appeal letter that you will receive in December. As many people consider their donations as year-end approaches, please support AMSAT's efforts to build and launch these satellites.

One other piece of news came out this past week (November 19) regarding Fox-1A. We were planning to include a digital camera built by Virginia Tech (VT). The flight board containing the camera has been built by VT and Lou McFadin, W5DID, had placed the conformal coating on the board. He shipped the camera back to VT for firmware installation. At this point, however, VT notified AMSAT that software issues were still preventing reliable operation of the camera. Therefore, it wasn't possible to achieve the revised deadline that AMSAT had negotiated with NASA ELaNa . NASA clearly wanted to see this camera fly and had worked out an arrangement for a revised delivery date. Consequently, AMSAT will place an unused experimental board on Fox-1A to fill out the space formerly to be occupied by the VT camera.

This is disappointing news. That said, VT is still working on the camera design in the expectation that it will fly on Fox-1C. While both Fox-1A and Fox-1C are expected to fly in third quarter 2015, the Fox-1C has a much later delivery date that provides time to continue development work on the camera.

Meanwhile, there is other positive news to share. AMSAT VP-Engineering Jerry Buxton, N0JY, reports that a major university has expressed their intention to provide a scientific payload for our Fox-1D spacecraft. Fox-1D is the fourth spacecraft being built. We don't have a launch opportunity yet identified; we must first apply for an ELaNa CubeSat Launch Initiative which we intend to do in Fall 2015. We expect to be able to announce the partnership and identify the university in the near future.

You will recall that one of the reasons for creating the Fox-1 CubeSat design is to provide a reliable spacecraft for flying scientific payloads in space while providing a platform for amateur radio. We view the flights of Fox-1A and Fox-1C as proof of concept demonstrating the viability of the Fox-1 design. Our hope is that we can continue to build on university relationships to provide more opportunities to fly the Fox-1 design, either as an AMSAT mission or university mission. In essence, we're encouraging an "OSCAR in every CubeSat".

Even though our first Fox-1 class satellite has yet to fly, and we've always intended to build four spacecraft, university awareness of our spacecraft design is becoming much greater. Researchers are interested in flying their scientific payloads and less interested in dealing with building satellites themselves. This interest is manifested in a high school that has asked AMSAT to work with them on flying their payload. This would require a fifth Fox-1 spacecraft (Fox-1E).

While we have not formally committed to support a fifth flight, Jerry is busy looking at our collection of Fox-1 Class parts inventory and has concluded that we can support a fifth mission. In preparation for a flight, we also develop a spare to protect the launch requirement. For example, the Fox-1A backup is the Fox-1C spacecraft. The Fox-1C backup is the Fox-1D spacecraft and the Fox-1B backup potentially becomes Fox-1E. We don't yet have a Fox-1B backup, but we do have the ability to build a spare for that flight that could become Fox-1E.

Stay tuned for more developments. The future is certainly looking brighter for more opportunities to fly in space.

Design AMSAT's Next Satellite

With the Fox-1 satellite design and construction program now coming to an end, it is time to start thinking about "what AMSAT should build next"? As I noted in my prior *Apogee View* column, we last asked this question in 2009 and the strategy that evolved at that time was that Fox-1 would be a 1U FM repeater supporting scientific payloads while Fox-2 would be a 3U SDX transponder supporting a variety of modes and scientific payloads. The versatility of the SDX approach was ably demonstrated by ARISSat-1 deployed from the ISS in August 2011. It supported a 16 KHz wide analog transponder in Mode B while providing a V-Band CW beacon and FM downlink of images, some telemetry and voice recordings, and a V-Band BPSK downlink to provide spacecraft and payload telemetry all at the same time from one SDX box.

So is this development progression still the best approach five years later? AMSAT is stepping back and evaluating other options that were not realistic in 2009. Taking the time to re-evaluate our options is an appropriate step to ensure that we move forward appropriately given today's environment.

One of the outcomes of the 2014 Board Meeting and AMSAT Space Symposium is that the AMSAT Board of Directors has endorsed an approach proposed by VP-Engineering Jerry Buxton, N0JY. In it, we provide an opportunity for the amateur community to develop their own concepts and provide input to AMSAT for consideration of what we should focus on next. Details on this approach were announced in an ANS released on October 17, 2014 and the *Guidebook* for submitting proposals is included in this edition of *AMSAT Journal*. Those who are interested in influencing the next satellite program should review the Guidebook, note the deadline (May 30, 2015) and start developing their concepts. Note that we are not looking for people to simply come forward and say, "AMSAT should do this….". Rather, we're looking for input from teams or individuals who are willing to develop a concept into a viable proposal and wish to participate in the development process should their concept be accepted.

Meanwhile, a group of individuals are interested in encouraging AMSAT to consider development of a 6U CubeSat for HEO. Due to the relatively small size and limited power capability of a 6U spacecraft versus a Phase 3 space frame,

their concept is to use a millimeter wave (MWW) transponder system in conjunction with digital coding to provide the capability for the system to work at HEO apogee. Their goal is to make it possible for such a system to provide the capability for multiple users to hold simultaneous two-way conversations. Their initial concept would require the development of a digital ground station to complement the satellite design. Given the distances involved at apogee, with limited space for antennas and solar panels on a 6U CubeSat, their concept would require the ability to keep the two high gain communications antennas pointing at the earth through three axis stabilization. As well, it would have deployable solar panels that would be aimed at the sun during the course of the orbit. The downlink would be at 24 GHz and the uplink at 10 GHz in order to have the proper gain antennas given the small footprint of the spacecraft.

Clearly, such an approach would be revolutionary in its design and implementation. The ground station would require a high degree of tracking accuracy in order to maneuver a 1-meter dish to within 0.5° . There is also discussion about adding an L/U analog transponder for use near perigee (when the spacecraft is less than 5,000 km).

Given the very significant costs of launching a more traditional Phase 3 satellite into a HEO orbit and the continuing expansion in the viability of CubeSats, along with the potential acceptance into the NASA ELaNa program that would provide a free launch, this is potentially an affordable way that a two-way voice communications capability could be used at an HEO apogee by employing such techniques. However, there are significant challenges to such an approach. There are a number of technical risks that must be evaluated, as well as an evaluation of the costs involved to determine the affordability of the design. There are concerns about the viability of the design from the ground station perspective, both in terms of technical issues as well as how the design would impact potential users.

I mention this concept because it was presented at the 2014 AMSAT Space Symposium by the group that is working on it. It represents an imaginative approach towards meeting the goal of providing an amateur satellite in HEO, given the focus on CubeSats. The individuals interested in this concept are excited about the prospects, but they also realize that a significant amount of work is required to flesh out their idea. This is an excellent example of a concept that would fit well in the "Design AMSAT's Next Satellite" process as a means of evaluating whether this idea, some other idea, or a combination of ideas should become the basis for AMSAT's next satellite project.

If you're interested in learning more about this particular concept, please contact Bryan Klofas, KF6ZEO (**bklofas@gmail.com**) who has agreed to serve as the team's project manager.

If you're interested in learning more about the "Design AMSAT's Next Satellite" program, please contact AMSAT VP-Engineering Jerry Buxton, N0JY (**n0jy@amsat.org**).

EAR/ITAR

On November 10, 2014, most commercial communications satellites formerly classified as Category XV (Spacecraft Systems and Associated Equipment) in the US Munitions List, and handled in accordance with the International Traffic and Arms Regulations (ITAR) managed by the Directorate of Defense Trade Controls (DDTC) within the Department of State, changed status. They are to be placed under the Commerce Control List (CCL), handled, in accordance with the Export Administrations Regulations (EAR), by the Bureau of Industry and Security (BIS) within the Department of Commerce. The transition includes amateur spacecraft.

This is good news for AMSAT in that we're no longer required to register each year as a manufacturer of defense articles which cost AMSAT $2,250.00 each year. In addition, we no longer have to contend with Technical Assistance Agreements (TAAs) that essentially prevented us from collaborating with foreign nationals on satellite projects.

The transition, however, does present some continuing concerns. The new rules imposed by the EAR still limit us in our ability to openly discuss technical information with foreign nationals unless it is first placed in the public domain. A process for obtaining permission to hold technical conversations must still be followed because the concept of deemed exports that has been applied for Category XV articles under ITAR is also included in the new EAR specifically for those items transferred from USML Category XV. While we expect the permission process to be easier than the old "Technical Assistance Agreement" under ITAR, to my knowledge the BIS has not yet specifically outlined the process and requirements for obtaining such permission. In fairness to the BIS, the concept of deemed exports is only now being introduced into the EAR, so they don't have any prior experience in defining the process for handling deemed exports. The BIS calls the current set of regulations "Interim Final Rules" suggesting that more changes/modifications are expected.

Consequently, it is still unclear how AMSAT or our volunteers will be impacted by the details of the new regulations. We're in the process of consulting with various organizations on the ramifications of the new rules. We've also had a conversation with officials of the Bureau of Industry and Security last June that suggested to us that there were still a number of details to be developed.

The bottom line is that we will continue to place information concerning our satellite projects in the public domain in order to openly discuss the details of our satellite programs. We traditionally publish materials in the *Proceedings* of our AMSAT Space Symposiums as well as placement in *The AMSAT Journal*.

If opportunities arise with a potential collaborative relationship with foreign nationals (such as other AMSAT organizations located in countries listed in the Department of Commerce Licensed Exemption STA Country List) exists, we will seek specific guidance from the BIS as to how to properly file for an export license to allow conversations and technical exchanges concerning the subject matter of interest. In the meantime, we will maintain our vigilance in terms of not inadvertently disseminating information to foreign nationals concerning current activities that are subject to export control.

Organizational Changes

The first action taken at the 2014 Board Meeting held Thursday, October 8 and Friday morning, October 9 was the election of senior officers. AMSAT is fortunate that all of the senior officers agreed to continue to serve in their current positions in 2015, providing a continuity of leadership.

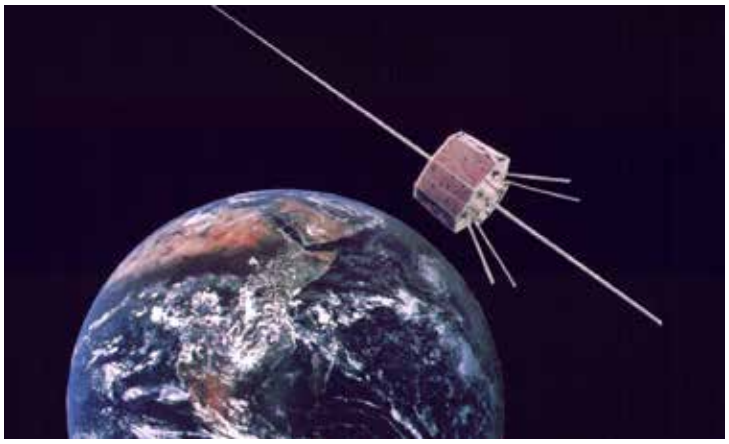
One change that was endorsed at the Board Meeting is the appointment of JoAnne Maenpaa, K9JKM, as VP-User Services. This appointment fills a position that has been held vacant since the resignation of Gould Smith, WA4SXM in February 2014 due to medical issues. JoAnne has played a significant role within User Services over the past few years, first as Editor of the AMSAT

continued on page 15 ...

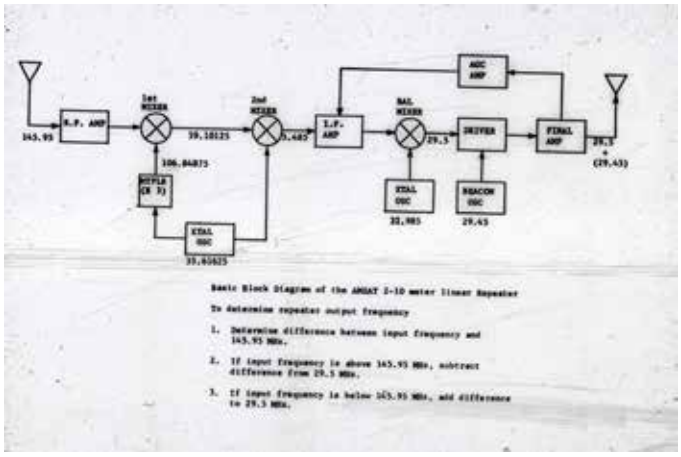
With thanks for photos and descriptions from Jan King, W3GEY; Perry Klein, W3PK; Rick Hambly, W2GPS; Bob McGwier, N4HY

40 years ago: AMSAT-OSCAR 7 was launched at 1711 UTC, November 15, 1974 from the Western Test Range at Vandenberg AFB in California

AO-7 became the second AMSAT-NA constructed and Phase 2 amateur radio satellite launched into Low Earth Orbit. It remained operational until a short circuit in a battery in 1981. On June 21, 2002 the satellite was heard again on its 2 meter beacon (145.9775 MHz CW) after 21 years of silence, and 27 years in space. AO-7 remains semi-operational with reliable power only from its solar panels. The restoration of service was due to the short circuited battery becoming an open circuit allowing the solar cells to power the spacecraft. When the satellite eclipses it powers down. It is operational while the solar panels are illuminated by sunlight.



AO-7 orbited a Mode A (145.850-950 MHz uplink and 29.400-500 MHz downlink) and Mode B (432.180-120 MHz uplink and 145.920-980 MHz downlink (inverted)) linear transponders and 29.500 and 145.700 MHz beacons. The 2304.1 MHz was never turned on because of international treaty constraints.

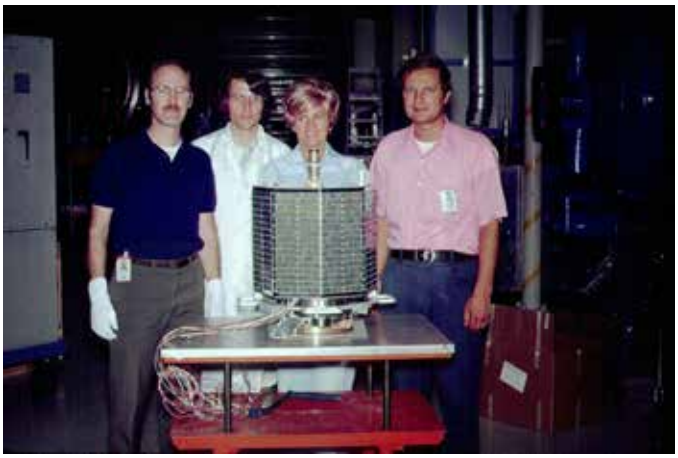


Block diagram of the 2-to-10 meter transponder. AO-6 and AO-7 shared the same 2-to-10 meter transponder design. A block diagram of the Mode B transponder (in Finnish) can be found on-line at: http://www.kolumbus.fi/michael.fletcher/ao_07b.gif

Completed module of the 2-to-10 meter transponder.

Lance Ginner, K6GSJ, Karl Meinzer, DJ4ZC and Jan, W3GEY, examining Karl's 70 cm-2 meter Mode B transponder

Karin & Karl Meinzer, DJ4ZC, Marie Marr (who did the wiring harness), Jan King, W3GEY, and Perry Klein, W3PK, with AO-7 before thermal-vacuum testing at NASA Goddard



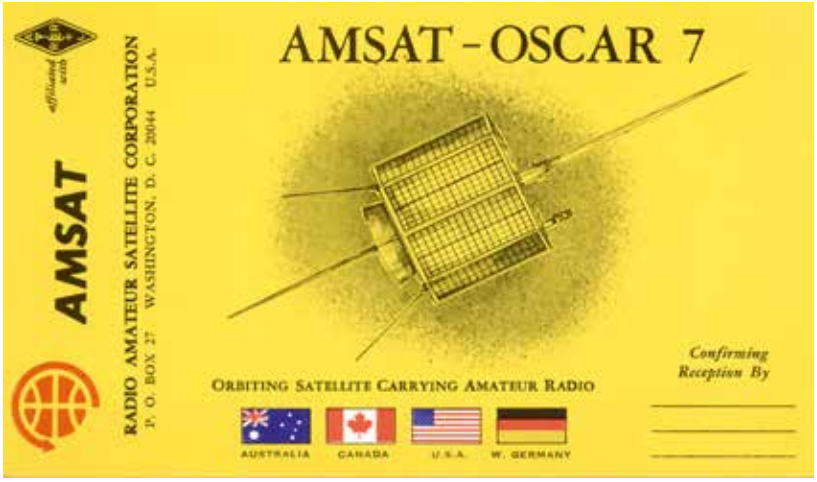
(top, left) - Dick Daniels, W4PUJ (SK) working on the 2-to-10 meter transponder.

(top, right) - OSCAR 7 with Dick Daniels W4PUJ, Jan King K8VTR-W3GEY, Marie Marr and Perry Klein K3JTE/now-W3PK.

(middle, left) - Shroud assembly prior to lift-off. AO-7 (small satellite on the right) was launched piggyback with ITOS-G (NOAA 4) and the Spanish INTASAT (small satellite on the left).

(middle, right) - Dick Daniels, W4PUJ (SK) at the Vandenberg launch complex.

(left) - Liftoff of the Delta launcher from Vandenberg Air Force Base, Lompoc, California.



(right) Photo of the AMSAT-OSCAR 7 QSL card.

A Checklist to Design The Next AMSAT Satellite!

Jerry Buxton, N0JY - AMSAT Vice President Engineering
n0jy@amsat.org

The following is a checklist of information that is considered necessary in a submission per the request for ideas for the design of the next AMSAT satellite.

Overview

The idea you are proposing must not simply be a suggestion of what AMSAT "should do". We are seeking a thorough high-level design which encompasses everything from concept to launch type. Because we are all volunteers working together toward amateur radio satellite communications, we are asking for and expect your involvement in the design you submit. While I can only offer limited input on your design, please feel free to contact me regarding the content of your proposal so that we can make the best of the opportunity.

Strategy

☐ Describe how the purpose and implementation of this idea fits into AMSAT-NA Engineering's long term strategy and the AMSAT-NA mission "keeping amateur radio in space".

AMSAT Engineering's Long Term Strategy

- Advancement of amateur radio satellite technical and communications skills
- Enhance international goodwill
- Grow and sustain a skilled pool of amateur radio satellite engineers
- Establish and maintain partnerships with educational institutions
- Develop a means to use hardware common to all opportunities

Design and Implementation

The design should include the following details.

☐ The RF design, such as modes, bands, antennas, ground station requirements, telemetry design, and link budget.

☐ The power system design, including batteries, solar panels, power supply, battery chargers, and power output.

☐ The cubesat configuration, i.e. 1U, 3U, 6U. This should also include any references to modularity or expandability per the AMSAT long term strategy.

☐ Science, technology, engineering, and math (STEM) education payloads, including details of the type of payload, purpose of the payload, telemetry requirements, payload sponsor, and an overview of the education plan.

☐ Propulsion, including type, capability, purpose, and source. Propulsion will require a waiver process.

☐ Thermal design considerations.

Cost and Resources

☐ A proposed plan of execution including manpower estimates with source (e.g. existing or recruited volunteers, or paid contractors), total manpower cost to complete such a project in the given timeline (e.g. number of volunteers and man hours for volunteers or cost estimates for hired work), the sources of unusual components and materials for the project, maturity of the components, and cost estimates for components and materials.

Timeline

☐ A timeline for a project which includes startup such as recruiting and requirements documentation, the execution of the design, construction, testing, and delivery stages and taking into account the capabilities and delivery of partner payloads and components, technology development, acquisition of components/materials, and acquisition of licenses such as NOAA imaging and IARU/FCC licensing.

Launch Opportunity

☐ The method of launch including desired orbit, launch provider (if specifically required), whether the launch proposed is an Educational Launch of Nanosatellites (ELaNa) candidate, and the substantially higher cost and source of funding for a commercial launch. If you intend to seek an ELaNa launch, please be familiar with the ELaNa Announcement of CubeSat Launch Initiative information so that your submission would meet the necessary criteria.

☐ Compliance with U.S. Government Orbital Debris Mitigation Standard Practices and NASA Technical Standard NASA-STD-8719.14A (with Change 1).

Risk Factors

☐ Provide an assessment of the risk involved in the execution and implementation of the idea including probability of success, technological (e.g. propulsion), volunteer manpower, and financial risks.

Partnerships (STEM experiments or materials/technology)

☐ Develop any partnerships with universities or other educational institutions through the AMSAT Vice President – Engineering.

☐ Establish a commitment to delivery contingent upon the acceptance of your proposal.

☐ Describe the resources and their purpose in the project.

Deliver Your Idea to AMSAT

☐ Submit your idea to the AMSAT Vice President - Engineering. After you have completed the work, mail the proposal to

AMSAT VP ENGINEERING
10605 CONCORD ST.
KENSINGTON, MD 20895

NOTICE TO FOREIGN NATIONALS

Due to United States International Traffic in Arms Regulations and Export Administration Regulations, discussions during the development of your ideas may be limited in scope due to export rules. We hope you understand this situation.

Upon acceptance of your proposal, AMSAT will seek authorization to conduct work with you on a project in a complete and proper manner.

I would like to thank you for your interest in helping to design the next AMSAT satellite! I look forward to working with you.

Jerry Buxton, NØJY
Vice President – Engineering
Radio Amateur Satellite Corp.
(AMSAT)

Jerry Buxton, N0JY - AMSAT Vice-President Engineering
n0jy@amsat.org

This is the first in a regular series that I will be writing for each edition of the *AMSAT Journal*.

Engineering is something that generally goes on behind the scenes, out of view of the public and even the membership until something comes out of the process either as the final result of what the engineering was about such as a new satellite, or in occasional updates to the membership at Dayton and the Symposium.

As a result, I think there's a bit of a disconnect between AMSAT Engineering and the members, because behind the scenes we are doing a LOT of work that you just don't hear about. That can give the impression that nothing is being done. Believe me, in my career where I spent most of my time working behind the scenes, everybody thought we were, as one observer accused, "playing pinochle and waiting to collect our pension".

There is lots to share about the work going on. The constraints that often prevent that are, first, the time involved in creating something to share and, second, determining what might be interesting enough to share that you should spend the time working on sharing it. I really think members want to know what is going on with even some of the mundane stuff and I occasionally take the time to share something on the AMSAT website, Twitter, and Facebook. I have my shack-cam (webcam) set up to overlook the "Fox Lab", if you want to drop in and look. However, as is common with behind the scenes stuff, there's a good chance you'll be looking at ... nothing happening. What you see is the Fox-1A engineering unit or, by the time you read this, flight model sitting on the table. What you don't see is the testing going on externally, because, at this stage of the game, the insides are all tweaked up. The testing is focused on the performance of the satellite in space, particularly details such as the FM repeater, telemetry, camera and experiment data, solar panel power, and so forth. That's an example of the part that is hard to share.

To give some perspective on the amount of work going in to Fox, the key members of our Engineering Team who are involved in these stages of the Fox-1 project have worked over 6000 hours in 2014. Over 5000 e-mails have been sent in our team mailing lists, over 100 hours have been spent on Go To Meeting, these only since April when I became VPE.

Hector KF5YXV, with the Fox-1A engineering model at Fox Labs

The "Big Board" at Fox Labs

Now, to share here are some of the things going on both Fox and otherwise:

- The Virginia Tech camera experiment has been completed and the Fox-1A flight unit and spare will be built the week of November 10. They will be tested as I described earlier for about three weeks. So, by the time you are reading this, expect to be hearing that we have passed the Day In The Life (DITL) testing that is required for the launch. Environmental testing should take place the week of December 8.
- The Fox-1C launch contract has been signed. We are working with Virginia Tech to supply another camera experiment as well as the development of a Whole Orbit Data (WOD) experiment. That experiment will capture and share micro-electro-mechanical system (MEMS) gyro spin data at a finer level than the Fox-1A experiment. This data will be available for classroom analysis of the cubesat spin. We expect to have an engineering unit in February, 2015.
- I have been working with some university partners on experiments for Fox-1D. Fox-1D will be built along

with Fox-1C as the flight spare, which will then position it ready for any launch that comes up at any time after its completion around June 2015. If no opportunities present themselves before that, we will file an ELaNa proposal in November 2015 and be ready for an immediate launch if accepted.

- We're building up the engineering team as we gear up for the next AMSAT project. As you probably know from the news, I have asked for anyone interested to submit ideas for what that next satellite may be. Barry also mentioned it in his Apogee View earlier this year. Fox-2 is a "blank sheet of paper" so, while the AMSAT Engineering Team will work on our own ideas, I expect that there may be some out there that will add value to the next project.

- As I mentioned, if you haven't seen the link and you want to tune in on the Fox Lab, you can go to my website:

  http://n0jy.org

  and click on the Station tab, scroll down, and look for the "shack-cam" link. I have limited it to 5 connections and 10 minutes viewing time because of my not-so-fast home internet service; nobody who might be interested in nothing happening can hog the connection. Also, check the still picture first. If it's more than 20 minutes old, then the cam is probably not live (nor am I).

Speaking of the Fox Lab, I had a visit from a couple of AMSAT members you may know, Clayton, W5PFG, and Hector, KF5YXV, on Halloween night. No tricks, but a real treat as Hector got to see what he called (and I have now dubbed) the "Fox Lab". Yes Virginia, the Fox "Big Board" appropriately had any ITAR sensitive information erased or turned around lest Hector try to steal it and run off to build a Cuban Fox!

Satrack - Doppler and AZ/EL Control Software

Pedro Converso, LU7ABF
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During a satellite pass, you often find yourself quite busy tracking the Doppler shift frequency tuning and maintaining the azimuth and elevation of your antennas. I have developed a free software application to handle these tasks.

Satrack.exe operates under Windows. It also requires the Microsoft .Net extensions (which are usually installed). The latest version of Satrack is available for download at:

http://amsat.org.ar/Satrack.htm

A web based version of Satrack is available at:

http://amsat.org.ar/sat.htm

Once it's installed and running, Satrack displays the status of all 56 satellites that it tracks. Figure 1 shows that satellites in range are marked as green, upcoming passes are marked as yellow and later passes are marked as blue. All time is displayed in local time.

The application detects and displays available COM Ports either 'Legacy' or via USB to Serial.

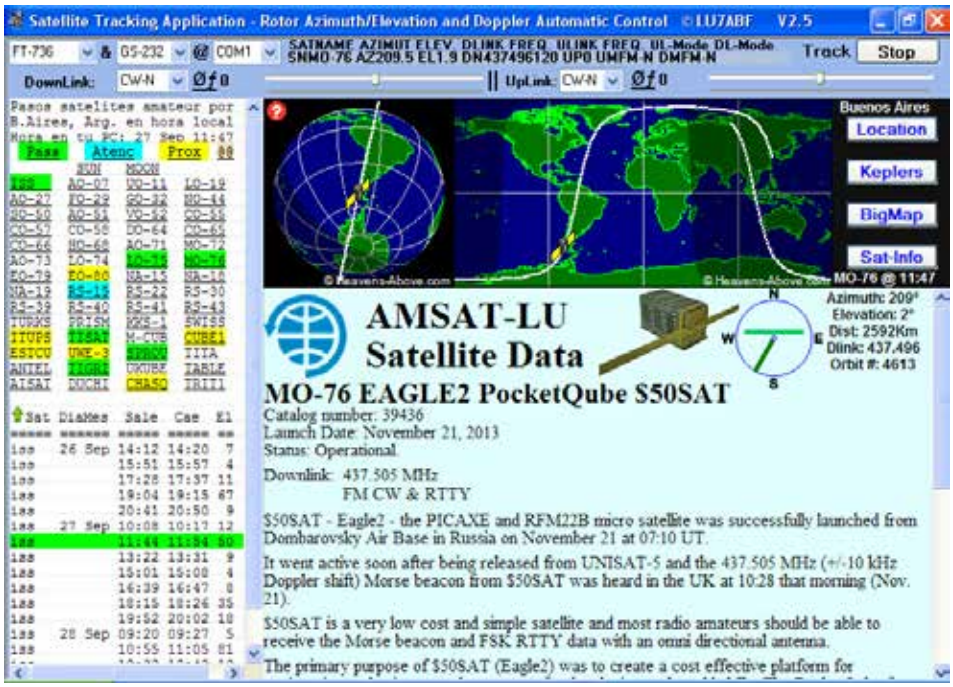


Figure 1: Satellites in range are marked as green, upcoming passes are marked as yellow and later passes are marked as blue. 56 satellites can be selected from the menu on the top, left of the application screen.

Program Setup

- Select which COM port is connected to your radio and rotor control. Satrack COM ports operated at 4800 baud.
- Select your transceiver or receiver (supports Yaesu, Kenwood, Icom, etc. I have tested with FT-736 & PCR-1000).
- Select the 'Location' closest to your QTH. This will also determine the local time for predictions.
- Select the type of rotor you are using.

Satellite Operation

Now you are ready to click on the satellite you wish to track/operate. (or Sun/Moon if required). The real time map shows the position of the satellite. Also displayed is the operating information of the selected satellite including frequencies and modes of operation (Figure 2). Selecting the 'Big Map' option shows a close up of the satellite tracking map (Figure 3). Keplerian

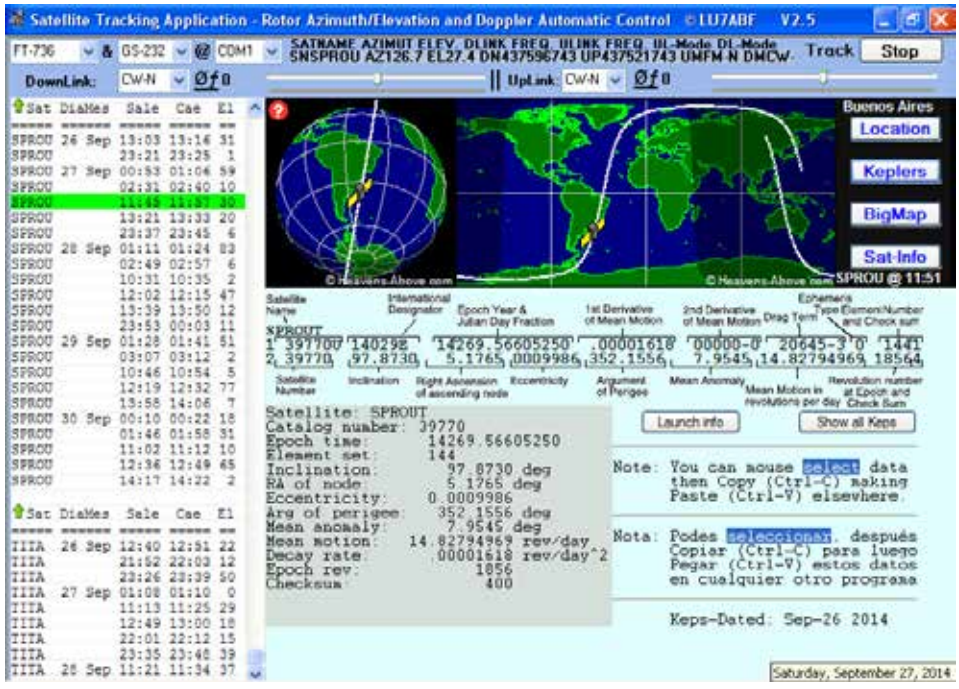


Figure 2: The realtime map shows the position of the satellite. Also displayed is the operating information of the selected satellite including frequencies and modes of operation.

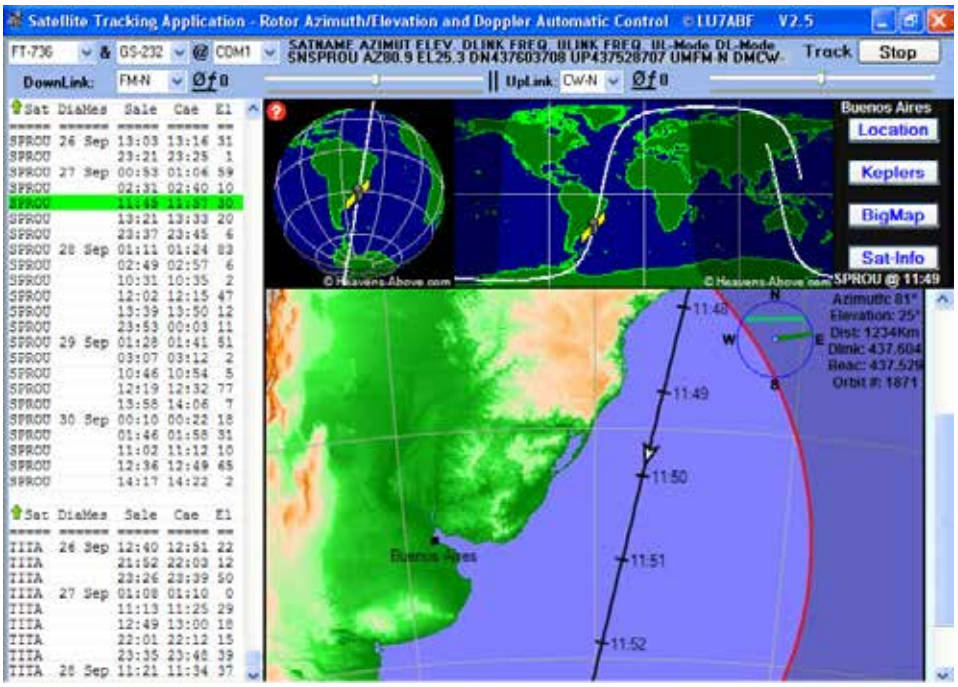


Figure 3: The 'Big Map' display option.

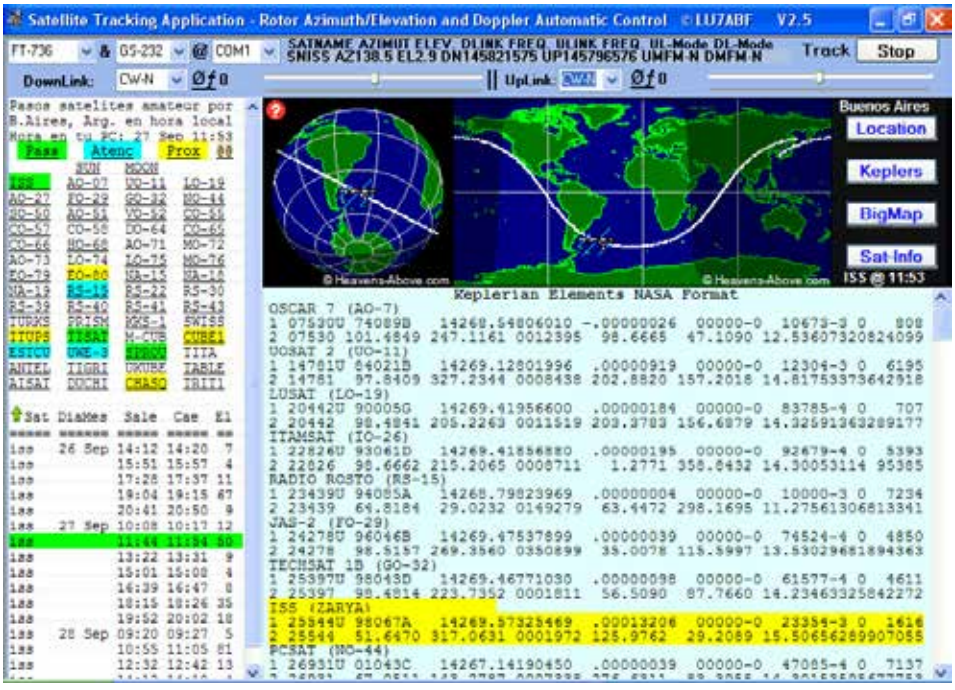


Figure 4: Kelperain Element screen.

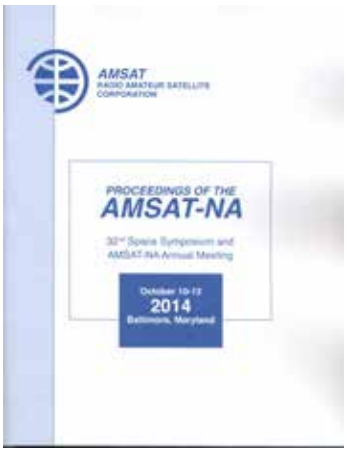
elements can also be viewed (Figure 4).

Clicking Track or Start/Stop, automatically sets reception and transmission frequencies and continuously updates the uplink and downlink Doppler-shifted frequencies. The mode of operation on the uplink and downlink frequencies (CW, USB, FM, etc.) can be selected.

Azimuth and elevation is shown in graphical form. The commands to the antenna rotor are sent providing elevation is greater than zero. If the rotor is in another COM, or you wish operate with two rigs, a second instance of the program could be run. From there on, there is nothing more to do than listen, and/or press PTT to transmit.

Just click on another satellite to select it. Satrack remembers the last selection of the Satellite and Location when re-started later.

The goal of this application is encourage more people to go into this exciting form of communication involving amateur satellites. I invite beta testers to contact me. Your comments and suggestions are welcome.



Proceedings of the AMSAT-NA 32nd Symposium and Annual Meeting

October 10-12, 2014, Baltimore, MD

The proceedings contains over 20 articles on subjects ranging from current satellite operations to detailed updates on the Fox Project.

If you could not make the meeting, this is a great source of the latest information.

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

Operating FO-29 from CN73

Lee (Doc) Ernstrom, WA7HQD
wa7hqd@arrl.net

On Saturday September 13, 2014, after signing up on the AMSAT-BB service and wondering why I wasn't getting any bounce-back messages, I finally received an e-mail from Bernhard, VA6BMJ, telling me that my messages were now being posted.

I responded to Bernhard by informing him of our plans to be in Bandon, Oregon vacationing and that I would take along my Alinco handi-talkie and Arrow antenna and attempt some satellite QSOs on SO-50.

Bernhard told me that he hadn't been on the FM satellites for a couple of years but that he might be willing to dust off his FT-817 and give it a try working me. He said that he spends his time on satellites nowadays working the linear bird FO-29 and has made some great long-distance QSOs through that one.

That got me thinking that perhaps I could take along my FT-897D, Arrow antenna, external battery, portable table and work FO-29 also.

Since I have never been on FO-29 I thought I would set up in the field behind my house and make some attempts at QSOs through that satellite for the first time. But first I needed to learn some basics linear transponder satellite usage techniques.

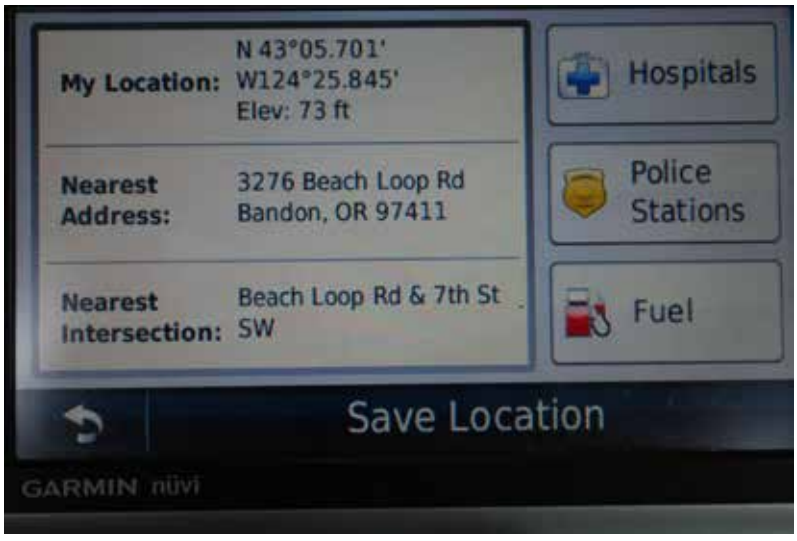
I did a YouTube search for the FO-29 satellite so that I could be schooled on how to access it and make contacts. I ran across a presentation by Wyatt, AC0RA, which was quite informative, and he made working the FO-29 satellite look quite easy.

So on September 15, 2014 I staged a dry run in my back field with my FT-897D, table and chair, Arrow antenna on a tripod. When the satellite became visible I worked W5PFG, W1AW/5, KG6NUB, and AC0RA with no problem on my 01:21 to 01:35 UTC pass of FO-29. That was real fun and not at all that difficult learning how to tune for Doppler shift.

On the next day on the 13:22 to 13:39 UTC pass I worked NM3B, N8RO, N5JF, WA4NVM, XE2BHL, N5UXT and XE1AO. At the end of that pass I felt like I was competent enough to make rapid-fire contacts in the short time window of a satellite pass, keep the antenna oriented in the right direction and do the logging.

Doc, WA7HQD looking for the bird. This is also Doc's QSL card photo.

Looking south along the Pacific beach.



GPS says I'm in CN73 .

Apogee View - continued from page 5 ...

"There's nothing to this," I thought to myself as I sat back in my comfortable chair gazing at my oriental pear trees bulging with ripe pears as I sat in the sun taking in the warm breeze. "When I get to Bandon, I will find a nice spot in the clear away from trees and buildings, set up my table and chair, connect the battery to the rig, and then enjoy three days of great satellite fun in 10-15 minute intervals a couple times a day while listening to the ocean waves in the background lapping onto the beach ."

Well, as it turned out, some of that came to pass on that first day in Bandon on September 22nd. The sun didn't make an appearance, however, because of the cloud cover, the warm ocean breeze wasn't that warm, and it certainly wasn't a breeze. And nothing there was dry because with the "ocean breeze" came mega-ocean mist that kept everything saturated with water.

"This is why antennas don't last very long on coastal areas," I thought to myself as I looked at the corroded bolts in the saturated wooden deck behind our bungalow. That first day, nevertheless, was very enjoyable working the FO-29 satellite.

On the 14:53 to 15:10 UTC pass I worked W7SXM, VA6BMJ and N6FUB. Later in the day, I worked AC0RA, NX9B, K4FEG, and N8IUP. I kept the rig wrapped in plastic to keep it dry and, at the end of the passes, I knocked the water droplets off the Arrow and took it inside to dry because I got reports that I was getting RF feedback on my signal. On the 01:07 – 0122 UTC pass on September 23rd, I worked AC0RA, KG6NUB, N8RO, K5PZ, W0DHB and K8IRC. By then, the weather started turning a little nasty. The wind picked up, the ocean spray was augmented by a light rain and I had a difficult time keeping the antenna pointed in the right direction.

And to add to the challenge, my wife told me that one of our dogs was very offended that I was outside and he was stuck inside. I hooked up his leash and wrapped it around my leg so I could keep him close. That turned out to be a mistake because, when it started raining Riley decided to wrap himself around the table legs and the antenna tripod. Fortunately, nothing toppled over.

It rained very hard during the night of September 23rd, so, in preparation for the 13:58 – 14:06 UTC pass of FO-29, I positioned our rented Chevy Suburban into the wind, opened up the hatch and operated FO-29 from the parking lot of the Windermere on the Beach resort. During that short pass I worked K8IRC, K4FEG, N5UXT and N8RO.

That evening on the 00:13-0026 UTC pass of FO-29 on September 24th, the wind had turned into a gale and the rain fell in torrents. My operating position in the rear of the Suburban, however, protected me well and kept the rain and wind off of me and the equipment. The Arrow antenna, however, suffered a couple topples from the wind and it was very difficult holding it down and operating at the same time.

I hadn't anticipated this problem. Later, one of the guys on the AMSAT BB emailed me and suggested that I tie a gallon of water from the hook on the bottom of the tripod and dangle it down to where it almost touches the ground giving the tripod the weight it needed to stay put in a strong wind. These things I hadn't even considered from the comfort of my sunny, warm, dry field behind my house in Syracuse, Utah several days earlier.

Nevertheless, on this evening pass, I had QSOs with WA4HFN, W7LRD, KC7MG, WC7V, KE4KOL, KB0VXN, AJ9K, and W0DHB.

On the 13:03 – 13:19 UTC pass on September 24th, the wind had let up considerably and the intense rain turned once again to a light spray. Again that morning, I operated from the open hatch of the Chevy Suburban and made my final FO-29 QSOs from CN73sc: KO4MA, KB1RVT, N5JF, WB2SIH, N5UXT, AA5PK, and WI9I.

The photo I used for my QSL card was taken by my wife of me working through satellite FO-29. I used a Yaesu FT-897D and an Arrow antenna from the rare grid square of CN73sc at the Windermere on the Beach resort in Bandon, Oregon. This particular operating position was directly behind our little bungalow in our semi-private back yard. In those three days, I completed 31 QSOs.

A big thanks goes out to everyone who worked me and to those who tried to get my attention through the pile-ups. I wish I could have worked everybody. We plan on returning next year and, by then, I hope to have another FT-897 D so I can listen to my downlink. By then I should have much more experience working linear satellites.

News Service and then as Editor of *The AMSAT Journal*. She's also assisted with development of web content for the AMSAT website and has participated in discussions about improving our Internet presence.

The VP-User Services serves as the team leader for all aspects of AMSAT that "touch" the AMSAT membership, including:

- AMSAT News Service (led by Lee McLamb, KU4OS)
- Contests and Awards (led by Bruce Paige, KK5DO)
- *AMSAT Journal* (currently held by JoAnne Maenpaa; we're looking for a new editor)
- Field Operations (led by Patrick Stoddard, WD9EWK)
- AMSAT Nets (led Keith Pugh, W5IU and Larry Brown, W7LB)
- Information Technology (led by Joe Fitzgerald, KM1P)

As the current *AMSAT Journal* editor, JoAnne will work at least through February 2015 as the editor while seeking a replacement. Her full transition to VP-User Services is contingent upon recruiting a suitable candidate to fill her current position as editor. Fortunately, she has a very strong team of capable individuals who continue to manage the day-to-day activities of their respective areas, so a delayed transition to her new position isn't having an immediate negative impact on the day-to-day activities under her new area of responsibility.

Best wishes this holiday season!

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Taking Part in the ARISS Project on a $500 Budget

Dr. Michael Butler, MA, MSc, PhD, G4OCR
M.K.Butler@bolton.ac.uk

Abstract

This article recaps the history of amateur scientific satellites over the past thirty-five years and the author's own interest in these developments throughout that time [1]. It outlines a how a school or college may become actively engaged with subjects in science, technology, engineering, and mathematics (STEM) in relation to space exploration using only modest funding and equipment that is widely available. In particular, we discuss the establishment of a ground station for the reception of digital (packet radio) and analogue (voice) radio transmissions from satellites, and communication via amateur satellite with other similarly equipped and authorised ground stations. The author's own experiments with this from home are outlined. Finally, we mention opportunities for schools and colleges to schedule brief live question and answer link-up sessions with astronauts and cosmonauts on board the International Space Station (ISS). One might expect involvement with the Amateur Radio onboard International Space Station (ARISS) project to be extremely costly. This is not the case. This article shows how much may be achieved for very minimal cost.

Orbital Satellites and Education – a Brief Early History

Since the beginning of the space age, starting with the launch of the first orbital satellite Sputnik 1 by Russia in 1957, numerous satellites have been placed in orbit around the earth. These continue to provide a host of services, including digital and analogue communications, weather forecasting, earth imaging for scientific research and surveillance.

It is not widely known, even among the amateur radio community, that small satellites were built by amateur experimenters at minimal financial cost as early as 1960. It is estimated that the first Orbital Satellite Carrying Amateur Radio (OSCAR) cost its constructors as little as twenty dollars. Since many of the components were military or civilian surplus stock, or else found or donated, nobody took much interest in the cost.

Keen experimenters and enthusiasts tend to focus on their technical interests for their own sake for recreation and enjoyment of the hobby. It continues to be important for the amateur radio community to support schools and colleges in accessing the basics of space technology for the education and inspiration of the young people. This is even more important in times of austerity. For the history of the OSCAR series of spacecraft [2], [3] and [4] are useful references, whilst [5] gives the contemporary picture.

In 1981, the University of Surrey, in the south of England, launched their first satellite UoSAT-1 (University Of Surrey Satellite), also known as OSCAR 9 (or UO-9) in the numbered sequence of amateur satellites. UoSAT was a significant departure from the eight previous OSCAR satellites. These had been primarily communication satellites so that, for example, OSCAR 7 (AO-7) and OSCAR 8 (AO-8) carried analogue transponders capable of accepting multiple amateur radio signals and relaying them to other stations within the satellite footprint which was typically around 3000 miles (or, roughly, 4800 kilometres) in diameter.

The first key departure was that UoSAT was primarily a scientific rather than a communications satellite. No transponder was carried and UoSAT was, instead, equipped with various experimental devices and sensors to monitor satellite health and function in real time. Data was broadcast continuously from its beacon on 145.825 MHz in the 2 meter VHF amateur allocation. The onboard sensors included:

- a CCD camera, 256 pixels square (with 16 grey levels) covering an earth surface of 500 km square,
- a scientific magnetometer, installed on the boom with a resolution of 2 nT in three axes, and
- two radiation counters: Geiger-Muller tubes measuring electron flux above threshold energies of 20 keV and 40 keV.

This information is taken from back of QSL card featured in [1].

The telemetry signal used a very basic 1200 baud digital format or an experimental digi-speaker which generated numerals in audible speech. This allowed listeners to discover aspects of the satellite's status and telemetry with no equipment beyond a suitable radio receiver or transceiver.

The second key departure was that UoSAT was more than simply a new means of extending the range of communications for hams as part of their radio experimentation. It was also intended to serve as an educational project for many newcomers beyond the existing amateur radio community. In particular, this took place via outreach by organised amateur radio clubs to young people in schools and colleges and their teachers.

The author was briefly involved with the UoSAT project at age 16 years, having recently gained his full licence with HF privileges in 1982. UoSAT was designed to be easily accessible with very simple equipment. Since the satellite transmitted a narrow-band FM signal on 145.825 MHz, receivers were easy to find and relatively inexpensive. The author used a Trio TR-2300 1 W synthesised FM transceiver, but VHF air/marine band receivers covering 118 MHz to 174 MHz also gave usable results for those not having an amateur radio license.

The telemetry was transmitted at 1200 baud, which is about one thousandth of the speed of a modern ADSL broadband Internet connection. It was decoded from the two-tone (1200 Hz and 2400 Hz) audio signal using a very simple analogue-to-digital converter which was based on the well-known, and frequently used, 555 timer chip. This was constructed at a cost of around $5. The digital high/low signal at around 5 V was compatible with the serial port of the BBC Microcomputer, a popular purchase for many schools in the UK in the early 1980s.

A 144 MHz vertical collinear antenna used at home gave fair audible results for the digi-speaker on satellite passes during which UoSAT did not rise to more than 45º elevation above the horizon. Much poorer results, however, were obtained for passes at higher elevations. Given the gain of the collinear antenna being achieved by concentrating RF energy in the horizontal plane, this was to be expected.

A custom-built double turnstile antenna featuring a pair of crossed dipoles spaced a quarter wavelength apart placed on the flat roof of the school gave much better results for all satellite passes. This allowed digital data to be extracted from the received audio and successfully displayed on the microcomputer with fair reliability.

These simple beginnings of accessible amateur space science and amateur satellite technology have expanded and developed at the Surrey Space Centre (SSC) within the University of Surrey over the subsequent third of a century. One of its satellites, UoSAT-2 (UO-11), has been in orbit for 30 years and is still transmitting.

This work has also continued into the twenty-first century at Surrey Satellite Technology

Limited (SSTL), an enterprise company linked to the University of Surrey. (It will be observing its 30th anniversary in 2015 and boasts new purpose-built accommodations and a staff of around 550 people.) Several original members of the UoSAT team at the University of Surrey and colleagues at SSTL, contribute to the continuing missions.

Further details about SSC and SSTL are given in the web links at the end of this article.

Over the past fifteen years or so, the International Space Station (ISS) has played a central and evolving role on continuing this tradition, particularly via the Amateur Radio onboard International Space Station (ARISS) project. It is with ARISS that the remainder of this article is concerned.

Benefits to Schools and Colleges

Participation in the ARISS project may greatly supplement and enhance programmes of study in all STEM curriculum areas, in particular, computing, electronic engineering and mathematics (the author's main subject). Much of the technology used for analogue and digital satellite communication is identical to that used for terrestrial communication. Hence, many schools and colleges already have much of the necessary equipment and technical expertise required. Students benefit from seeing first-hand the application of theory presented in their theory-based classes to communication to, from and via spacecraft in low earth orbit. This becomes a powerful means of attracting students to courses in these areas, and also generates significant publicity via local media for the school or college undertaking the project.

Resources

This section briefly describes the hardware and software required as a minimum to get started with ARISS.

A. Computer Hardware

All that is required is a PC with Windows XP, 7, 8 or similar operating system. For basic tests, a PC is not absolutely necessary; a text terminal such as a DEC VT220 or Wyse terminal suffices. The author used this approach in early home experiments.

B. Computer Software

Equipping the chosen PC with a range of appropriate software packages significantly expands the scope of what may be achieved. Many of these are available free of charge to educational establishments or the amateur home experimenter.

Satellite tracking software is useful, and may be stand-alone or incorporated within other software. Alternatively, web resources such as:

http://www.heavens-above.com

may be used.

For communication via the ISS using digital packet radio, the original standard software for the Automatic Position Reporting System (APRS) using the AX.25 protocol is UI-View32. This is available free of charge (although a charitable donation is requested). The author has found that UI-View32 performs flawlessly and has more than sufficient features. Some, however, prefer alternative systems that have been developed since UI-View32 appeared. Figures 1 and 2 show screen views of results using this configuration.

Where external hardware has serial connectors using RS-432 serial protocol, a good serial/USB converter is essential. Software to configure virtual com ports within the PC is also needed. The N8VBvCOM software has worked well for the author, and is also available free of charge.

The Radio Society of Great Britain publication Computers in Amateur Radio [6] gives a useful introduction to the role of computer hardware and software in amateur radio. In particular, the book includes a chapter on APRS.

C. Radio Equipment

For single-band ARISS operation, any 144 MHz band FM transceiver capable of around 10 W output will suffice. Although a dedicated beam antenna which may be steered for altitude and azimuth is best, fairly good results can be achieved with a quarter-wave vertical antenna or other vertical collinear antenna dedicated to the 144 MHz band.

For dual-band operation, a transceiver capable of working "split" between the 144 MHz band and the 430 MHz band is required. These, however, are somewhat more expensive. Dual-band antennas for 144 MHz and 430 MHz are also readily available and give reasonable results.

D. Licenses for Transmission

Transmission of radio signals to satellites requires a licence from the relevant authority. This, however, may require training and examination requirements above and beyond those of a regular "novice" amateur radio license, depending on the country one is operating from.

However, anyone may readily participate in the ARISS project provided that a licensee is always present and retains charge of the transceiver when transmissions are taking place. Anybody, though, may receive the ARISS signals.

Technical Details

On board the ISS itself, ARISS has generally used a single transceiver that has usually operated continuously.

During Expeditions 10 through 13 (2004 – 2006), when the author was first interested in ARISS, the transceiver operated as a single-band digipeater (that is, digital packet repeater) with a downlink frequency of 145.800 MHz and an uplink of 145.990 MHz.

For a time, this was changed, and the digipeater used the downlink frequency in the 144 MHz band, but had uplink in the 432 MHz band. This made working via the digipeater less straightforward than previously, as a dual-band transceiver became necessary. Also, because Doppler shift is more significant at 432 MHz than it is at 144 MHz, manual or automatic correction became more of an issue.

Presently, as of October 2014, ARISS uses a single frequency of 145.825 MHz for both uplink and downlink.

The digipeater uses the very well-known AX.25 protocol. This is essentially the now rather aged X25 link layer protocol that was widely used for computer networks during the 1980s. AX.25 includes amateur call signs plus subsidiary identifiers (such as G4OCR-2) or other formal equivalents (such as WIDE1-1 or TRACE2-2 to implement packet routing) instead of hardware ("MAC") addresses used for well-known link layer protocols such as Ethernet or ADSL.

For a full explanation of seven layer OSI protocol stack (in which Layer 1 is the physical electronics, Layer 2 is the link layer to pass bits over wires or via RF channels, Layer 3 is for switching frames between channels, and so on), Reference [7] may be consulted. This book remains the standard reference.

All popular amateur packet radio hardware and software is compatible with AX.25, and UI-View32 allows flexible use of AX.25 in unconnected mode. To explain, it is usual, over a reliable path (such as via RF to a local DX cluster), to maintain a virtual connection throughout a contact via sequential frame numbers and "ack" (i. e., acknowledgement) signals. This allows occasional missed or corrupted packets to be sent again, as required.

In unconnected mode, "ack" signals and frame numbers are omitted. Packets are sent at 1200 baud, rather than the speeds of 9600 baud and

above used elsewhere within packet radio. This allows relatively old and unsophisticated radio equipment to be used with a good level of success. It also compensates considerably for the tendency of space-earth transmissions to be much less reliable in general than terrestrial communications between fixed stations.

There is a store-and-forward bulletin board system (call sign RS0ISS-11) which is a novel way to relay a message to another station outside the current satellite footprint. However, over heavily populated parts of the world, the congestion caused by the popularity of ARISS sometimes makes it difficult or impossible to use the brief ISS pass to successfully send and receive the necessary packets to either access or post messages.

Better, and much more usable over Europe and North America, is the digipeater (call sign RS0ISS-3). To use this, the TNC is placed in converse mode and packets sent with unproto string are set appropriately. "CQ via RS0ISS-3" simply allows a call to all stations, while "APRS via RS0ISS-3" or similar for specific software alerts that position and other information is included. Of course, a specific call, plus SSID, addresses that packet to the chosen station. This is without establishing a connection to the packet station on board the ISS or, for that matter, to any other station. This drastically reduces the congestion caused by "ack" packets and repeated packets passed back and forth between the ground stations and the ISS station when AX.25 is used as a connection-oriented protocol.

As the operator learns to use the software, with due regard to traffic and other conditions on frequency, a good sense of when to choose to resend a packet is gradually gained.

Activities and Projects for Schools and Colleges to Explore

There are many different activities relating to ARISS and other amateur satellites that students of any age at schools or colleges might enjoy as both recreation and as a means of learning the space science of low earth orbit. Some suggestions are:

1. reception and study of satellite data and telemetry giving status of onboard spacecraft systems,

2. voice and data communications with other ground stations via OSCAR and other amateur radio satellites, demonstrating the application of satellite technology to global communication,

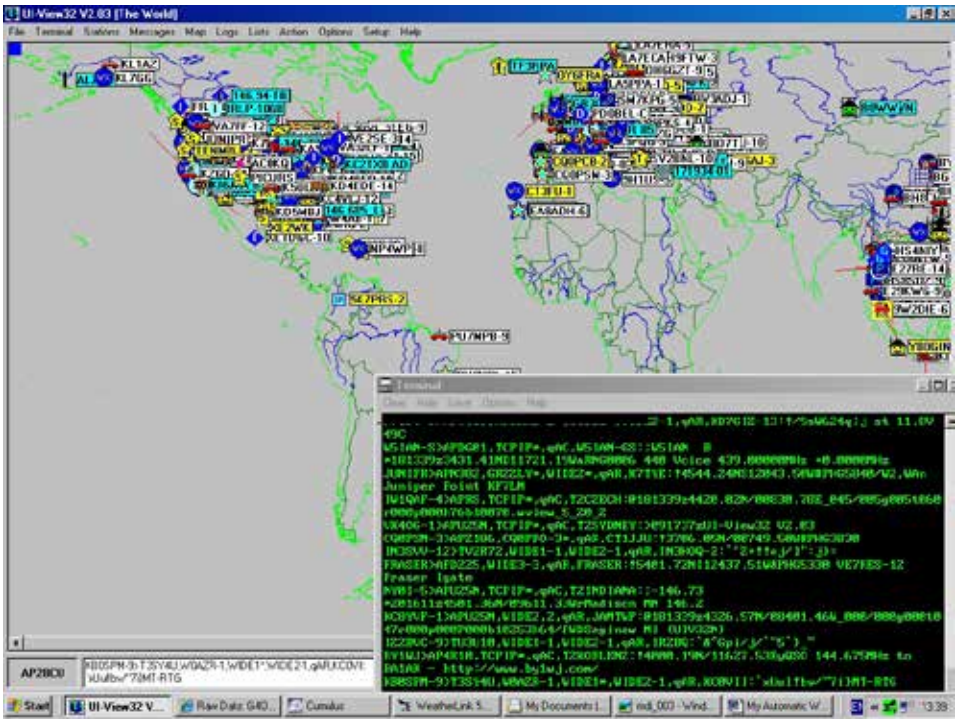

Figure 1. Screen capture from laptop running Windows XP of fifteen seconds of global APRS activity, via Internet from APRS server. UI-View32 monitor window features.

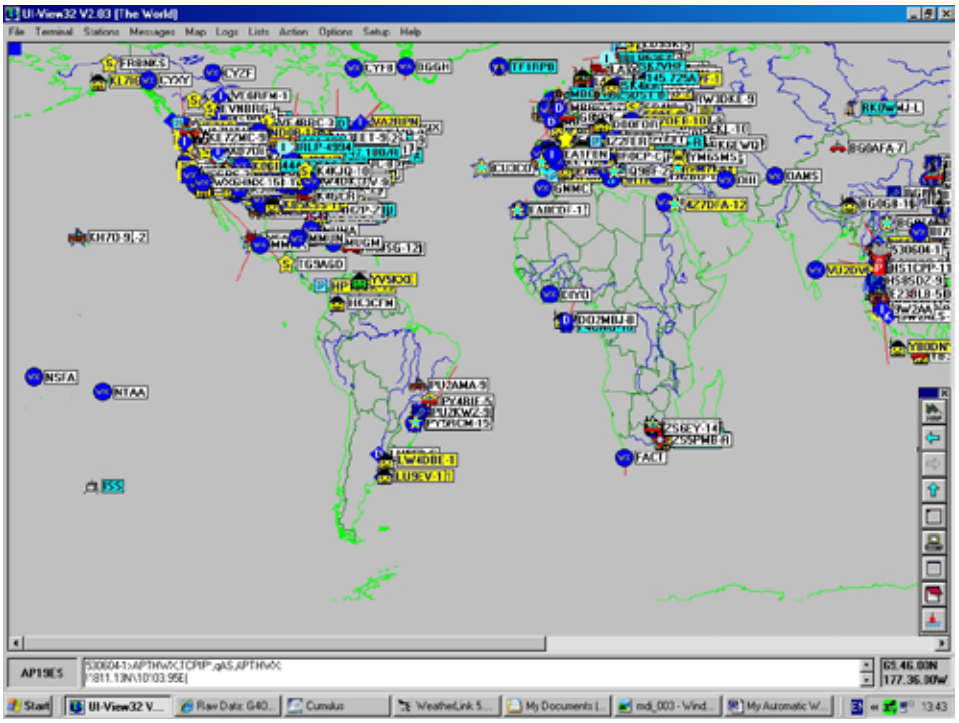

Figure 2. Screen capture, similar to Figure 1 but with thirty seconds duration recorded –notice the ISS over southern Pacific Ocean towards bottom left of this image.

3. packet radio communication via RS0ISS with or without APRS, as described above, and

4. communication with the crew of the International Space Station; many schools and colleges have already done this, and generated much publicity as a result.

The last of these is technically easy to achieve, but it requires a great deal of planning and liaison in order to arrange a suitable date and time for the contact. One must also plan precisely who is doing what so that things go smoothly on the day, arrange local media coverage in order to gain best pay-off both for the school and for ARISS itself, and so on.

Whilst members of the ISS expeditions (and of Mir, prior to its decay from orbit) have long actively sought and enjoyed contacts via radio with students and pupils in colleges and schools, their free time is very limited indeed. As might be expected, there is a high demand for this limited time. However, they give priority to communication with schools and colleges for educational purposes and are very willing to set up scheduled contacts. An application form for this is available on-line.

The Author's Own ARISS Project of 2004

For his own personal interest, and as a pilot study of the feasibility of getting involved with ARISS on a modest budget, the author set up his own mini space project during 2004. The equipment used, with approximate second hand costs (in U. S. dollars), were as shown in Table 1.

The radio far exceeds the specification needed for single-band ARISS work, since any 144 MHz FM transceiver capable operating on 145.825 MHz and producing a signal of around 10 W would suffice. Many single-band FM transceivers are available for around $150. Many modern transceivers have a TNC built in so that there is no need for a separate unit. Thus, a very basic ARISS ground station may be established within the stated budget of 500 U. S. dollars or equivalent.

Using this very basic equipment, and no software beyond virtual terminal to emulate VT220, a sample of the transcript of a single pass is shown in Table 2. The two packets from the author's own station echoed via the ISS transceiver are highlighted in bold type. Some messages from other stations are plain text, whilst others (APRS) contain strings of characters showing position of the station and other information such as status. Note that time stamps on each packet are provided by the PK-232 TNC and are not included in any of the RF traffic.

Using an actual VT220 worked equally well from the point of view of testing the set-up, but the PC is useful for storing, editing and recalling transcripts from multiple passes over a period of time. The author received around twenty confirmations of receiving packet signals from his station both via email and by QSL card from all major European countries. In particular, a very colourful QSL card was received from IW1RGA in Bogliasco, Italy.

Ten Years Later: 2014

During the early stages of preparing this article in March 2014, the author used the APRS software UI-View32 with a laptop computer running Windows XP. The station was otherwise the same as detailed earlier in this article, with the FT726-R, PK-232 and dual-band vertical antenna still in use and performing well.

Figures 3 and 4 show actual screen shots of passes of the ISS in which packets from the author's station G4OCR-2 were successfully digipeated via RS0ISS on the space station, received by other ground stations and fed into the APRS database. The first screen shot shows a typical pass of the ISS over Europe during evening local time, whilst the second shows a single packet addressed to EMAIL being gated to the Internet via ground stations EI7IG in the Republic of Ireland an IS0EBO in Sardinia.

Figures 5, 6, and 7 show details of the author's station.

Table 1 – 2004 ARISS Project Station

Component	Description	Cost
Radio	Yaesu FT726-R transceiver, covering all modes on 50, 144 and 430 MHz amateur allocations	$700
Antenna	Co-linear vertical antenna for 144 MHz and 430 MHz	$150
TNC	AEA Packratt PK232	$80
Computer	Used PC	$100

Table 2 – Extract From a Transcript of a Typical Pass of the ISS

23:03:18	RS0ISS-11*>PD5HW: CMD(F/K/M/R/W/B/H/?)>
00:00:00	EB5JTR-5>RS0ISS-3*>APRS:=3340.25N\00026.31WSsimulador-GPS www.EB5JTR.esp.st {UISS30}
00:00:00	RS0ISS-11*>PD5HW: 161 81 17-Mar/0521 LU5YBR>ALL Hola a todos desde Neuquen
00:00:00	PD1ART>RS0ISS-3*>APRS::BLN :Hello to NL997,ON6NL and other stations
00:00:00	**G4OCR>RS0ISS-3*>CQ: Greetings from IO83UK! PSE send report to: michael@bolton.ac.uk**
00:00:00	PD1ART>RS0ISS-3*>APRS: =5252.10N/00600.10E-M.Krechting@home.nl PSE send Report {UISS33}
00:00:00	EB5JTR-5>RS0ISS-3*>APRS::eb5jtr-5 :!out 1 10101011
00:00:00	PD0RKC-3>RS0ISS-3*>APRS: Hi ALL pse sent me a report to: pd0rkc@amsat.org
00:00:00	PD0RKC-3>RS0ISS-3*>APRS:=5308.45N/00602.30ESHi ALL pse sent me a report to: pd0rkc@amsat.org
00:00:00	EB5JTR-5>RS0ISS-3*>APRS:=3340.25N\00026.31WSsimulador-GPS www.EB5JTR.esp.st {UISS30}
23:04:30	RS0ISS-11*>PD5HW [D]
00:00:00	RS0ISS-11*>PD0SDO: Welcome to RS0ISS's message board System Ver 1.50 98140 Bytes free
00:00:00	RS0ISS-11*>DL7OL: Welcome to RS0ISS's message board System Ver 1.50 98140 Bytes free
00:00:00	RS0ISS-11*>DL7OL:CMD(F/K/M/R/W/B/H/?)>
00:00:00	PD0SDO>RS0ISS-3*>APRS:=5306.15N\00607.30ES73' Via Satellite {UISS33}
00:00:00	PD0SDO>RS0ISS-3*>APRS::EMAIL :pd0sdo@amsat.org Hello 73's Jan via Satellite
00:00:00	**G4OCR>RS0ISS-3*>CQ:Greetings from IO83UK! PSE send report to: michael@bolton.ac.uk**

Closing Comments

Professor Sir Martin Sweeting, founder and Executive Chair of SSTL, said the following about the significance of the UoSATs [8]:

"UoSAT-1 and 2 embodied the true spirit of amateur radio projects with contributions from international radio amateurs from the US, Germany, Hungary and U. K. They stimulated a new trend in amateur space science and technology within amateur radio and went on

Figure 3. Image capture from UI-View32, 14th December 2011 showing a typical pass of the ISS over Europe with stations from many western and central Europe shown.

Figure 4. Image capture from UI-View32, 1st April 2014 showing EI7IG and IS0EBO Internet gates in the Republic of Ireland and Sardinia and the author's own station. A packet addressed to EMAIL was received at both remote stations and gated to the Internet, reaching the author's work email address within a few minutes

to influence the professional space community showing what small satellites could achieve using modern COTS devices." (N. B. COTS = commercial off the shelf.)

References

[1] Butler, Michael, Full Circle – 1983 to 2014 Inspiration of a Student, The AMSAT Journal Vol. 37, No. 3, May/June 2014.

[2] The ARRL Satellite Anthology – Best of QST articles, 3rd edition, ARRL, 1994.

[3] Branegan, John, Space Radio Handbook, RSGB, 1991.

[4] Davidoff, Martin, The Radio Amateur's Satellite Handbook, ARRL, 2000.

[5] Ford, Steve, WB8IMY, The ARRL Satellite Handbook, ARRL, 2013.

[6] White, Steve, G3ZVW, ed., Computers in Amateur Radio, RSGB, 2013.

[7] Tanenbaum, Andrew S., Computer Networks, 3rd edition, Prentice-Hall, 1996.

[8] Personal communication.

Websites

Main ARISS website:

http://ariss.org

Online tracking of the ISS and most amateur satellites:

http://heavens-above.com

SSTL, an enterprise company linked to the University of Surrey:

http://www.sstl.co.uk

SSC at the University of Surrey:

http://surrey.ac.uk/ssc

Main page for APRS developed by Bob Bruninga, WB4APR:

http://aprs.org

Original page for access to APRS database of recent packets:

http://findu.com

Latest information on ARISS contacts with schools for Europe:

http://www.ariss-eu.org/schoolcontacts.htm

UI-View32 APRS software by Roger Barker, G4IDE:

http://www.ui-view.net/

Download of N8VB Virtual COM Port software:

http://download.cnet.com/N8VB-vCOM-Virtual-Serial-Port-Driver/3000-2098_4-91665.html

About The Author

Michael, G4OCR, has taught mathematics at the University of Bolton (about 15 miles from Manchester) since September 1992. This includes teaching for bachelor's degrees in both mathematics and electronic engineering. He is a member of the Radio Society of Great Britain (RSGB), the Group for Earth Observation (GEO), the London Mathematical Society (LMS) and the European Mathematical Society (EMS).

(top, left) Figure 5. The author's Packratt TNC and monitor for packet radio operations (photo Easter 2014)

(top, right) Figure 6. The author's QSL card image, taken 2008

(bottom, left) Figure 7. Aerials/antennas. They are (left to right) a 70 MHz 5/8-wavelength vertical (4 m band) with a 50 MHz (6 m) dipole on the same mast; the Davis Vantage VUE weather station integrated sensor suite appears just behind; a Diamond CP-6 vertical for 3.5/7/14/21/28 MHz that also does fine on 18 MHz and 24 MHz with an A. T. U.; a double-turnstile for reception of NOAA 15/18/19 weather sats Automatic Picture Transmission on 137MHz mounted on the chimney stack; a Watson W-300 dual band vertical for 144 MHz (2 m) and 430 MHz (70 cm). The Watson W-300 is the antenna used at the author's station for ARISS work.

Collection of AMSAT Journals and Other Publications - 1969 through 1993

This DVD contains a collection of AMSAT Newsletters, Orbit Magazine, Satellite Report, and the AMSAT Journal, ranging from 1969 through 2013. An incredible source of both history and technical information, much still applicable. The archive is nearly complete for the various publications, though a few older issues are missing.

Price is $30 + $5 shipping on-line at:

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

Pat Kilroy, N8PK, AMSAT Area Coordinator for Washington, D.C. and Maryland staffed the AMSAT table Mason-Dixon Hamfest in Westminster, Md. on October 26, 2014. This hamfest was sponsored by the Carroll Co. ARC. Pat's demonstrations included a large LED display running SatPC32, CubeSat info, and an Arrow antenna on a heavy-duty camera tripod. Pat says the biggest seller was the Getting Started manual and the laminated Frequency Chart combo.

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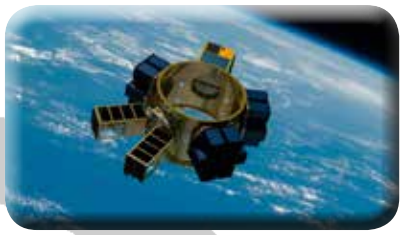
AMSAT Fox-1C $125,000 Launch Initiative Goal ... Your Help is Needed!

AMSAT is excited to announce a launch opportunity for the Fox-1C Cubesat. AMSAT has teamed with Spaceflight for integration and launch utilizing Spaceflight's SHERPA system to a sun-synchronous orbit in the third quarter of 2015.

Fox-1C is the third of four Fox-1 series satellites under development, with Fox-1A and RadFXsat/Fox-1B launching through the NASA ELaNa program. Fox-1C will carry an FM repeater system for amateur radio use by radio hams and listeners worldwide. Further details on the satellite and launch will be made available as soon as released.

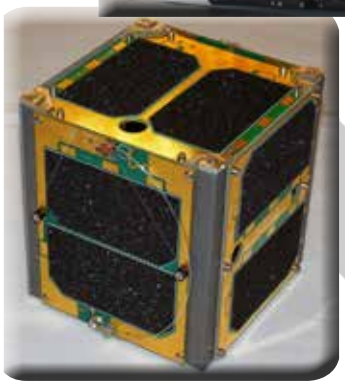
AMSAT has an immediate need to raise funds to cover both the launch contract and additional materials for construction and testing for Fox-1C. We have set a fundraising goal of $125,000 to cover these expenses over the next 12 months, and allow us to continue to keep amateur radio in space.



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-1C 1U Cubesat launched on the Spaceflight's initial SHERPA flight in 3Q 2015.

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-1C ... Join Now!

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.

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	❒	$600 one time
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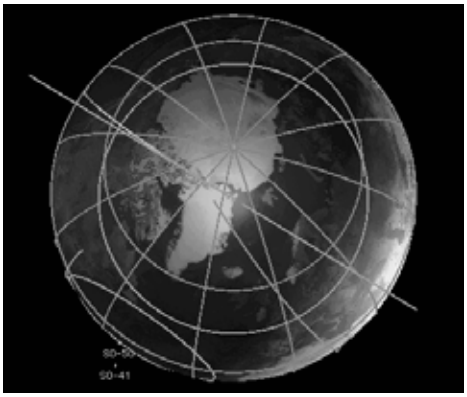

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AMSAT Fox-1 Challenge Coin Revealed at 2014 Space Symposium

AMSAT is excited to announce that a new premium collectable is now 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.

The coins are scheduled for delivery just prior to the 2014 AMSAT Space Symposium, and will be first distributed to donors attending the Symposium. Coins will also be made available to qualifying donors that have contributed since the Fox-1C announcement on July 18, 2014 *upon request*. 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

The Fox program is designed to provide a platform for university experiments in space, as well as provide FM repeater capability for radio amateurs worldwide. Fox-1A and 1C are set to launch in 2015, and Fox-1B (also known as RadFXSat) is awaiting NASA ELaNa launch assignment. Further information on the Fox project can be found at:

http://www.amsat.org

Visit the FundRazr crowdsourcing app at: http://fnd.us/c/6pz92

Patrick Stoddard, WD9EWK - AMSAT Director of Field Operations
wd9ewk@amsat.org

AMSAT's Field Operations has been busy in 2014. For the year, through early November, AMSAT has been represented at 28 different event across the USA, not including the large presence AMSAT had at three other events - Orlando Hamcation, Dayton Hamvention, and the ARRL Centennial Convention in Hartford. Thanks to everyone who has been out to help "fly the flag" for AMSAT!

As always, AMSAT has needs for volunteers. I could use more help to spread the AMSAT message at hamfests, conventions, and other events all the time. Area Coordinators are volunteers who represent AMSAT, whether by staffing a booth or table at a hamfest, giving presentations for radio clubs or other organizations, or staging public demonstrations of amateur satellite communications.

Area Coordinators also become the local experts for amateur satellites, answering questions from people in their area. We only ask Area Coordinators to represent AMSAT at one event a year, although there are no restrictions on the number of events.

If you are considering becoming an Area Coordinator, please e-mail me via:

wd9ewk@amsat.org.

Photos and videos of Patrick, WD9EWK, and John, K8YSE at the Tucson Hamfest in Marana, Arizona can be found on-line at:

https://twitter.com/WD9EWK/media

To view Patrick's @WD9EWK Twitter feed in a browser, use this link:

https://twitter.com/WD9EWK

(left) The AMSAT booth at the 2014 ARRL Southwestern Division Convention in San Diego on September 12-14, 2014. Patrick Stoddard WD9EWK/VA7EWK represented AMSAT at this convention, talking with hams from throughout the southwestern USA *and northern Mexico.*

(right) The AMSAT booth at the 2014 ARRL Southwestern Division Convention in San Diego on September 12-14, 2014. Patrick Stoddard WD9EWK/VA7EWK represented AMSAT at this convention, talking with hams from throughout the southwestern USA and northern Mexico.

(above) AMSAT table at the Tucson Hamfest in Marana, Arizona on November 8, 2014. Many thanks to the Oro Valley Amateur Radio Club for providing AMSAT with space for our booth. I also have to thank John Papay K8YSE/7, who helped me with the AMSAT booth at the hamfest. The equipment for satellite demonstrations included two complete satellite stations Patrick had his portable all-mode satellite station at the hamfest. John brought his portable station which includes an Icom IC-910H, an Arrow Antennas 2m/70cm Yagi on tripod, and a laptop with SatPC32.

(left) Paul Stoetzer N8HM, AMSAT Area Coordinator, giving a presentation for the HacDC Amateur Radio Club in Washington DC on October 8, 2014 (the Wednesday night before the AMSAT Symposium in Baltimore). After an enjoyable presentation, Paul and most of the club went on the roof of the meeting place, a church, north of the White House, to give a demonstration of amateur satellite operating on AO-73. Patrick used his portable station from his car parked along 16th Street NW to listen in on Paul's activity and also to talk about satellite operating.

ARISS 2014: A Program in Transition

Originally published in the Proceedings of the 2014 AMSAT Space Symposium in Baltimore, MD by Frank H. Bauer, KA3HDO; Gaston Bertels, ON4WF; Debra Johnson, K1DMJ; E. Mike McCardel, KC8YLD; Lou McFadin, W5DID; Mark Steiner, K3MS; Dave Taylor, W8AAS; Stefan Wagener, VE4NSA; and Rosalie White, K1STO

Abstract

2014 has been a quite challenging year for the ARISS Program. As the ARISS team prepared for an all-important international meeting in the Netherlands, NASA Education informed us that all funding was dropped for our program and that we needed to start shutting down. In addition, the operations team has experienced somewhat spotty school contact downlink signals from the radio system in the Columbus module. Despite these hurdles, the ARISS-US team was able to restructure its support within NASA to keep ARISS alive. We are working with our space agency and external partners to sustain and grow ARISS in the future. This paper describes the vast variety of ARISS activities and events that were accomplished even as the program struggled to rise up against the unique challenges that threatened its very survival.

Cancellation Challenge and Need for Transition: Keeping ARISS Alive Despite Cancellation Notification

When the international working group called ARISS was newly formed in 1996, ARISS was primarily sponsored by two NASA organizations—Headquarters Education, with support from the Johnson Space Center and the Goddard Space Flight Center, and the ISS Program Office led from the Johnson Space Center. Their in-kind and real-dollar support to ARISS, coupled with the support from the ARRL, AMSAT-NA and our ARISS international partners and space agencies, enabled the ARISS team to develop a comprehensive program that included hardware development, on-orbit hardware deployment, school group operations, international coordination, lesson plan development and educational outreach.

In the 2009-2012 timeframe, as the ISS was starting to transition from construction to operations, NASA modified the ARISS co-sponsorship with Education and the ISS Program Office. In this timeframe, ARISS custodianship was transferred solely to NASA Education's Teaching from Space (TFS) Education Flight Project at the Johnson Space Center. This change put ARISS (and numerous other education programs) in a very vulnerable position as the NASA Education budget was ten times smaller than the ISS Program Office. NASA Education has also been subjected to large budget cuts—past and present.

In 2013 and in 2014, NASA Education received massive budget cuts. In 2013 ARISS survived the United States government sequester, shutdown and multiple education budget cuts virtually unscathed because ARISS is a high interest, high priority, high impact, and very low cost educational outreach endeavor for NASA. However, in the spring of 2014, NASA HQ Education lost the bulk of its flight projects funding, requiring nearly all of its flight projects to shut down. In April 2014, ARISS was told that NASA Education was cancelling the program and, in August 2014, all support from Teaching from Space, in-kind and real dollar, was terminated. The result: if no other supporting organization within NASA could be found, then ARISS would no longer be supported by NASA and operations would cease.

Anticipating these dire consequences months prior, the ARISS-US leadership team developed a strategy to form relationships and partnerships with other NASA organizations, outside of Education, that might be interested in real dollar and in-kind support of ARISS. We are also formulating partnership strategies with organizations outside of NASA.

Frank Bauer, AMSAT-NA Vice President for Human Spaceflight Programs, had been working with the strategic communication and education office of NASA-Headquarters' Space Communications and Navigation (SCaN) program regarding an ARISS school contact with a science organization in the United Arab Emirates. SCaN has very strong synergies with ARISS. They are responsible for all of NASA's space communication, including ISS communications. They are responsible for NASA's ground stations and TDRS communication relay satellites. They provide spectrum management for the agency. And they have the largest segment of amateur radio operators within any NASA group. Also, they see the importance of ARISS for both its education possibilities as well as its backup communications capability for the ISS.

Frank was able to make the case for direct support of ARISS by SCaN. Real-dollar support has been provided by SCaN to bridge the gap left by NASA Education in fiscal year 2014 (which ends September 30, 2014) as well as a major portion of fiscal year 2015. This critical funding ensures that our payload operations support (provided by Kenneth Ransom) is sustained, keeping ARISS operational.

Frank Bauer and E. Mike McCardel, AMSAT-NA V.P. for Education, attended the ISS Research and Development Conference in June 2014 to present a paper on ARISS and to network with teams inside and outside NASA. Prior to this, Frank started discussions with the ISS Program Office and its contractors regarding the future of ARISS. The conference represented an outstanding venue to discuss ARISS' future face-to-face with many of the Program Office leaders, including the Chief Scientist and the leadership of ISS Utilization, where all the payloads are maintained (including ARISS). The ISS Program Office was interested in reestablishing a direct relationship with ARISS and suggested that ARISS was a great educational outreach payload for the ISS National Lab, which is being run for the ISS Program Office by a non-profit organization called CASIS, the Center for the Advancement of Science in Space. (http://www.iss-casis.org).

E. Mike and Frank met with several leaders of CASIS during the ISS conference regarding ARISS and future strategies. One of them was the chair of the Education session, who had heard our paper presentation on ARISS the previous day. They all felt that ARISS was a good program fit for CASIS and they ultimately requested that ARISS submit a proposal to officially become an ISS Lab payload under CASIS. That proposal was submitted and, in the meantime, the ISS Program Office began to host ARISS resources, including operations contract support, that were going to be suspended when Teaching from Space shut down in August.

Currently the ARISS-US leadership team is waiting to hear from CASIS, and in the meantime continues to work with the ISS Program Office and SCaN to solidify NASA support of ARISS. Discussions remain to be held with other NASA organizations that have expressed interest in ARISS. And, with CASIS, we are looking at outside organizations for sustained support.

Through all this threat of cancellation and upheaval, the ARISS Program has continued to operate day-to-day and no educational opportunities have been missed. This is a testament to the dedication of the ARISS team, particularly the many volunteers world-wide that make the ARISS Program feasible and so successful.

It is important to note that if the ARISS Program is to remain alive, to be sustained, and to grow, it is critically important that the program develop a team that can garner outside support—in-kind and real-dollar support. This will require individuals with skills in business development, fundraising and networking. If you have these skills or are willing to learn, please contact Frank Bauer: **ka3hdo@verizon.net**.

2014 Highlights

ESTEC Meeting

ARISS-International delegates met at the European Space Agency's ESTEC facility in the Netherlands on April 3-5, 2014—the first face-to-face meeting in 2½ years. Presiding was AMSAT-NA Vice President for Human Spaceflight Programs Frank Bauer, KA3HDO. Participating were Rosalie White, K1STO, as US ARISS Delegate for ARRL (she is also ARISS-International Secretary-Treasurer), Dave Taylor, W8AAS, as US ARISS Delegate for AMSAT-NA, and Stefan Wagener, VE4NSA/VE4SW, as Canadian ARISS Delegate for AMSAT-NA. Also taking part were US team members Mark

Steiner, K3MS; Lou McFadin, W5DID; Kerry Banke, N6IZW; and Tim Bosma, W6MU. Former ESA astronaut Gerhard Thiele, DG1KIL, welcomed meeting attendees. He heads ESA's Human Spaceflight and Operations Strategic Planning and Outreach office. He said that ESA recognizes the benefit to students of being able to communicate with the ISS crew via Amateur Radio, and said students learn a great deal from ARISS activities.

ARISS delegates reviewed the program's direction and new objectives, and expressed agreement on wanting to enhance collaboration among all ARISS team members. Talks were presented and discussions were held on current and future technical and hardware topics, including long-term equipment possibilities, education items, operations matters, personnel themes, and more. Some specific examples included Lou McFadin's presentation of the advantages of a mobile VHF/UHF transceiver with higher power capability for the Columbus Module, like the Kenwood D-700 in the Service Module. He spoke about future use of software-defined radios that are remotely controlled from the ground and equipment deployed outside the ISS that is remotely accessed by the crew through portable handhelds or Bluetooth-like devices. In the future, ham gear has to take up very little space in the ISS, and allow for operation across multiple modules. Kerry Banke presented other ideas for enhancing ARISS equipment, and solicited input.

ARISS-Europe Delegate Gaston Bertels, ON4WF, presented ideas for using the Ham Video TV system during school contacts. Everyone worked together at the meeting as a world team, and momentum surged with newer team members stepping up to work on new objectives. A number of votes were taken, and the team continues to network on action items suggested during the meeting.

Delegates attended from all five ARISS regions: Canada, Europe, Japan, Russia, and the US. NASA Johnson Space Center Teaching from Space Office representative Trinesha Dixon took part in the meeting via teleconference. The meeting ended with a heart-felt thank you to all team members.

Canada Highlights

The ARISS Canada international delegation went through a full transformation this past year with a change in both ARISS delegates. AMSAT-NA tapped Stefan Wagener, VE4NSA/VE4SW to replace Maurice-André Vignault, VE3VIG/VE2MA who recently decided to step down. And long-time Canada delegate for the Radio Amateurs of Canada (RAC), Daniel Lamoureux, VE2KA, also submitted his resignation this year to focus on some family health situations. As a result, Ian MacFarquhar, VE9IM, was selected as the ARISS delegate for the RAC.

Key Regional Leaders in the Canadian team include Operations/Mentor team members: Steve McFarlane, VE3TDB, Brian Jackson,

Stefan Wagener, VE4NSA

VE6JBJ, Wayne Harasimovitch, VE1WPH, Lori McFarlane, School Teacher and Claude Lacasse, Audio/Video specialist, and Canada's member of the Project Selection and Use Committee: Darin Cowan, VE3OIJ

The Canada operations/mentor team was responsible for 18 of the 23 contacts made by Canadian Astronaut Chris Hadfield.

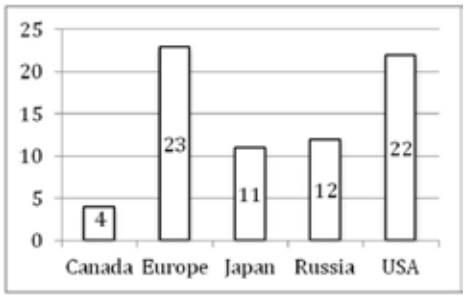
A major initiative that is being mentored by delegate Stefan Wagener is Canada's first ARISS Telebridge station and Ham TV station, VE4ISS, at the Shaftesbury High School, Winnipeg, Manitoba. VE4ISS is now fully operational and fully integrated into the Shaftesbury High School activities, bringing ARISS STEM into the school. All operators (students and teachers) are licensed ham radio operators. ARISS STEM activities include school contact management, radio operation and setup. The students learn the physics of ISS orbits and orbit prediction and they learn about radio waves and radio communication. Prior to their support to ARISS, Shaftesbury teachers Rob Striemer, VE4SHS and Adrian Deakin, VA4AMD received the Canadian Teaching Excellence Award from Prime Minister Stephen Harper for excellence in science and teaching.

Operations Highlights

Educational Contacts

During the past year (September 16, 2013 to September 15, 2014) we conducted 72 successful contacts in 17 countries. This is down from the 95 contacts in 21 countries of the previous year, largely due to program uncertainty and gaps in the program caused by the US government shutdown and periods of no available crew in the US Operational Segment of ISS.

Overall, about 72% of contacts involved a ground station at the students' location. This is slightly above the typical 67%.



Contacts by Region

Telebridge Changes

As a result of a US proposal at the last ARISS-International delegates meeting, the ARISS-I Operations Committee has assumed management of the ARISS telebridge network. In this role, they will be responsible for selection and oversight of the telebridge stations. We made this change to enhance international cooperation within ARISS. AMSAT-NA originated the telebridge network for Shuttle contacts during the SAREX program and was responsible for it up to this change.

There are currently nine designated telebridge stations, although currently several of these are unavailable for various reasons, including maintenance. We anticipate adding two stations in the next few months: a new station in Winnipeg, Canada (VE4ISS, at Shaftesbury High School) and a relocated station in Belgium (ON4ISS).

SSTV Enhancements

The Russian ARISS team has recently been conducting SSTV operations from the Zvezda module. This was made possible by a newly flown cable to connect a laptop to the Kenwood D710 radio and newly updated MMSSTV software. SSTV operation is part of an on-going experiment supported by the Moscow Aviation Institute (MAI) and a new experiment called "About Gagarin from Space". In the past, SSTV transmissions have used Martin 2, Robot 36, and a few other modes. The latest transmissions used the higher definition PB180 mode.

Volunteers

The US operations team is looking for additional help with several jobs, particularly with technical guidance to schools (mentors). We also need someone familiar with Python to modify and help with qualification of some custom orbit prediction software. If you are interested in joining the team, contact Dave Taylor (w8aas@amsat.org).

Educational Outcomes

The US team is completing the schools last selected through the proposal process managed by NASA Education's Teaching From Space (TFS) program and 12 of the schools recruited through partner contacts after the TFS proposal process was shut down. ARISS has about 5 US schools remaining in the queue to be completed. A list of the US schools completed in 2014 is shown in Table 1.

School Feedback

As part of the ARISS activity, we solicit comments and feedback from the schools in a survey we send to each school. Some feedback we received this past year included:

"This was an incredible event. We were able to bring our entire school in on this and it was a pivotal moment for our school year and perhaps the lives of those in attendance. We attempted to bring in some other schools as our guests to the event but that was a challenge given most public schools' inability to be so flexible with their schedules at the last minute."

"It was amazing. I think it sent chills down the spine of everyone there. I just hope those kids appreciate what a singular and wonderful experience they had. I know I do."

"We had an amazing experience with ARISS! Our technical/radio mentors were excellent and did much to help us prepare for the contact. The engagement of all 900 students present was evident in the silence during the time of contact...a priceless moment for all."

"It exceeded our expectations! It created a great interest in both amateur radio and in space exploration. We were disappointed that more news media and school officials did not attend, even though invitations and press releases were sent in enough time."

1st Quarter		School Name	City	State
1/8/2014	Direct	Berkeley Middle School	Williamsburg	VA
1/18/2014	Direct	Wallingford STEM Academy	Wallingford	CT
2/19/14	Tele-bridge	Marymount University/ Ft Belvoir Elementary School	Arlington	VA
2/19/14	Tele-bridge	Delaware Township School	Sergeantsville	NJ
2/28/14	Direct	Exploration Place	Wichita	KS
3/3/2014	Direct	Central Square Middle School	Central Square	NY
3/5/2014	Direct	Rock Bridge Elementary School	Columbia	MO
3/14/2014	Direct	Warren Consolidated Schools	Warren	MI
3/20/2014	Direct	Forest Knolls Elementary School	Silver Spring	MD
2nd Quarter				
4/21/2014	Direct	Dixon Elementary School	Holly Ridge	NC
5/1/2014	Direct	Hidden Oaks Middle School	Prior Lake	MN
3rd Quarter				
8/2/2014	Tele-bridge	Space Jam 8	Rantoul	IL
8/22/2014	Tele-bridge	Zuni Hills Elementary School	Sun City	AZ
8/26/14	Direct	Winfree Bryant Middle School	Lebanon	TN
8/27/14	Direct	Dorothy Grant Elementary School	Fontana	CA
9/3/2014	Direct	Evansville Day School	Evansville	IN
9/8/2014	Direct	St. Joan of Arc School	Lisle	IL
9/9/2014	Direct	Lanier Middle School and Lanier Cluster Schools	Sugar Hill	GA

Table 1: U.S. Schools ARISS Contacts to date for 2014

Forest Knolls Elementary School ARISS Radio Station

Students Participating in the ARISS Contact at the Dorothy Grant Elementary School

"The experience was very successful and all the students were affected positively, not just those asking questions. The initial minute of the contact

Radio Communication Education at the Dorothy Grant Elementary School

was poor quality, with not all questions/answers understood, and the conversation ended more abruptly than I would have liked. However, our students were prepared for all these possibilities."

Educational Topics Explored

From the school feedback, we learned that some of the educational topics explored in preparation for the contact included:

- Living and working on the ISS
- Space History
- The electromagnetic spectrum and radio
- Ham radio etiquette/talking on the radio, basic radio procedures, and oral communication skills
- NASA experiments on the ISS, parts of the ISS, spacesuits, and other NASA/space related topics
- Amateur radio satellites & how they work
- Pre-service teachers completed unit grid and plan on space exploration. An integrated approach to teaching through STEM in Education.
- We had a variety of guest speakers from the ham radio club and NASA Langley. The space topics ranged from rocket science, to living and working in space, to the future of space research.

Additional School Highlights

From the Evansville Day School
The mayor of Evansville declared today as "Evansville Day School Science Day."

http://www.courierpress.com/news/2014/may/24/eds-students-will-use-ham-radio-to-make-contact

From the Winfree Bryant Middle School
We had an absolute fantastic experience!!!! We have received emails, texts, and calls from schools all over the United States who watched our contact. Thank you so much for the opportunity to connect the ISS. -- from 8th grade teacher, Tammy Sheppard

https://www.youtube.com/watch?v=wdNvbWKaHvE

MAREA progress

MAREA is an acronym that stands for **Mars Lander/Marine Amateur Radio Robotics Exploration Activity.** It is a hands-on learning activity designed to engage students in learning programming skills for command and control of land or marine robots, and to use Amateur Radio packet communications as the means of communication. Students can access the "network" of Amateur Radio packet stations, including stations on the International Space Station, to relay commands to robots in remote locations, down the hall, in the gymnasium, in a park across town, on a local stream or at a partner school in another state.

Ten teachers were provided a UHF transceiver and the necessary hardware to execute MAREA contacts at the ARRL Teacher's Institute this past summer. They plan to execute packet command of robots via station to station control. With development of a satellite ground station they will also be able to relay commands through the ISS. This is the beginning of a much larger educational outreach activity that ARISS would like to conduct with MAREA and schools. It will depend on being able to offer teachers more training and resources for satellite ground stations, more reliable access to the ISS packet station and the impetus to get involved with satellite communications activities as more satellite assets become available for teachers to rely upon for classroom use.

School Proposal Solicitation

As NASA's TFS program is no longer supporting ARISS, ARRL and AMSAT-NA are leading the effort to revise the US proposal process and to solicit new ARISS school groups through a request for proposals. Our plans are to open the proposal window for 2015 contacts in October 2014. Two proposal windows are planned per year, a proposal window from October-November and a window from February-March. These will enable January and May selection of schools.

Ham TV

An exciting addition to the amateur radio equipment onboard the ISS was accomplished in 2014: the installation and commissioning of the Digital Amateur Television (DATV) transmitter dubbed "Ham Video" during the late summer. (Ham TV refers to the whole system, including the Ham Video transmitter and contacts using DATV.)

It all began over a decade ago, not with the transmitter, but with one of the other requirements for a radio system: the antenna. Getting permission to use feedlines that pass through the pressure hull of an ISS module is a very difficult process due to safety concerns for pressurization. ARISS-Europe chairman Gaston Bertels ON4WF took on that challenge in April 2002 when he submitted a request to Dr. Joerg Feustel-Bueschel, the General Manager of the ESA Human Space Flight Directorate. The proposal was to install amateur radio antennas on the nadir of Columbus, the European ISS module then under construction. One of the key parts of the proposal was the feedthroughs that would allow access to the antennas from inside Columbus. On February 19, 2003 a meeting was convened at EADS-Astrium, Bremen where the proposal to install patch antennas on the nadir of Columbus was received favorably.

ESA agreed to let ARISS install patch antennas for UHF, L-band and S-band. Another challenge arose in that ARISS was to support the development and manufacturing. Dr. Pawel Kabacik, professor of the Institute of Telecommunications and Acoustics, Wroclaw University of Technology, Poland, accepted the responsibility to develop and manufacture the antennas. On October 9-10, 2007 L/S-band antennas ARISS 41 and ARISS 43 were installed on the exterior of the Columbus Module in the high bay of Kennedy Space Center in preparation for launch to the ISS. After a successful launch and installation, ARISS had L/S band antennas on the Columbus Module of the US Operations Segment, accessible from inside the module.

On March 8, 2014 at 13:28 UTC the ARISS International Ham TV system was powered up and operated for the first time by astronaut Mike Hopkins. Transmissions of Digital Television signals on S-Band were sent from the International Space Station to a set of ground stations over Europe and around the world. Commissioning of Ham TV was conducted by a team led by AMSAT-Italy, ARISS-Europe and the European Space Agency, utilizing several amateur radio ground stations set up throughout Italy. Most notably, a large, high-gain dish antenna at the Matera, Italy ground station was employed along with other smaller dish antennas. ARISS has several additional Ham TV ground stations around the world listening and providing reception reports as part of the "blank transmission" mode, a mode where the equipment will be fully operational but with no camera connected.
As many of you know, it is quite a challenge to develop, certify, fly and operate equipment on the ISS. The Ham TV system was presented

Winfree Bryant Middle School

Ham Video transmitter for the Ham TV system

Mike Hopkins operates Ham TV during commissioning

with additional challenges, including a wide bandwidth signal that requires very weak signal reception, very high Doppler effects, and S-Band frequencies that are shared with the ubiquitous WiFi signals that are prevalent around the world. The ARISS team has developed several innovative design techniques and mitigation strategies to work around each of these challenges and, as a result, Ham TV experimentation was extremely successful.

The latest information and status on Ham TV is available through the ARISS-Europe site:

http://www.ariss-eu.org

and through the ARISS-International website:

http://www.ariss.org.

Hardware Upgrades

One of the challenges being faced by ARISS is the need for a higher-power transmitter in the Columbus Module. The initial transceiver used in the Russian segment shortly after the ISS was first inhabited was the Ericsson radio, transmitting approximately 5 watts through a re-purposed telemetry antenna on the FGB. Later, antennas were mounted on the outside of the Russian Service Module and a Kenwood D-700 was installed to replace the Ericsson. The ARISS community was able to enjoy easy arm-chair copy from the 25 W of output power provided by the Kenwood D-700 in the Service Module.

Currently the only radios approved for use on the Columbus Module are the Ericsson VHF and UHF units, and the Ham Video transmitter. It is a high priority for the ARISS team to install a higher-power radio (such as the Kenwood D710) in the Columbus Module. To accomplish this, ARISS will need to acquire adequate power supplies and the radios, perform safety certification on the equipment, complete the payload documentation, train the crew, and up-mass the new radio system. This will require additional funding that will not be provided by NASA or other space agencies. We anticipate this will require $100K-125K.

The success of the Ham TV system, coupled with challenging school downlink signals that have degraded the ARISS school experience, has prompted discussions on increasing the usefulness and capabilities of the resources in the Columbus Module.

Items being considered are:

- A higher-power VHF/UHF/L-band Transceiver (such as Kenwood D-710).
- A suitable power supply to handle all of the current and future components in the Columbus Module. One potential unit would be the Kayser Italia-designed "Portable Power Supply", or PPS.
- Slide Show and Camera unit based on the Raspberry Pi microprocessor. It would also provide a looping slide show from a file on a standard USB stick, and would allow for continuous Ham TV transmission. This would increase the chances to receive Ham TV on the ground for development and improvement of ground station capabilities.
- Multifunctional Beacon comprised of an S-band CW beacon with telemetry and a transponder function (L-band up and S-band down).

ARISS will be sharing the status of these development efforts ideas as they progress.

Summary and Conclusions

Throughout this challenging year of 2014 the ARISS team was able to keep the program running day-to-day, thanks to the dedication of the ARISS team. 72 schools in 17 countries have had a once in a lifetime opportunity to talk with crewmembers onboard the ISS. A new Ham TV system and improved SSTV capabilities have been deployed onboard the ISS and are ready for utilization. New capabilities are being discussed and developed for future deployment. In the short term, a higher power radio system in the Columbus module is a top priority.

Despite the challenges of this transition year, the future for ARISS is bright. Key to this successful organization and accomplishments are the many volunteers world-wide who dedicate their time and resources to making ARISS the longest-running successful education and outreach payload on the ISS.

An Eyeball QSO in India

Burns Fisher W2BFJ
w2bfj@amsat.org

Those of us who like to travel know that there is no better experience than the chance to make and meet friends outside of the normal tourist circles; visiting friends in their homes or at an interesting place off the beaten path is always a special event. I have had a chance to get to know many customers and co-workers at locations around the world thanks to my work, but a recent Eyeball QSO in India gave me yet another way to meet people and another reason to appreciate being a ham and an AMSAT member.

Late this summer, I was in Bangalore (aka Bangaluru) India on business. Because I had seen their names in AMSAT-BB posts, I sent email to Mani, VU2WMY and Nitin, VU3TYG. Mani is the Secretary of the Upragh Amateur Radio Club at the India Space Research Organization and director of Educational Outreach for AMSAT-India, and Nitin is the Secretary of AMSAT-India. Both are frequent posters on the AMSAT Bulletin Board; it was Mani who gave us the sad news a few months ago that VO-52 had stopped operating after more than 9 years of service.

To my delight, Nitin arranged for me to visit his home and meet a group of AMSAT-India members: Nitin, Mani, Bopana VU3BOP, and Amal, VU2GDX as well as Nitin's wife and his son (and future ham) Arjun. We sat around in Nitin's shack rag-chewing about everything from Arjun's latest school project to Nitin's hobby of collecting satellite telemetry. What a great way to spend a Sunday afternoon!

Satellites were, of course, a big topic of conversation; I was sorry that because of ITAR I could not share nearly as much about Fox-1 as they could about VO-52. My new friends were very understanding; some of them are very familiar with government restrictions since they work for ISRO, the India Space Research Organization. I asked how they sorted out what they could talk about with me and what they could not. The answer is that they are careful to do AMSAT work in different areas than they work on for ISRO. Thus if they are talking about VO-52 or other AMSAT work, they know that they are not talking about areas of their work they must keep secret. I, on the other hand, as Fox-1 Flight Software Co-Leader, had to keep pausing before saying anything about Fox-1 to confirm to myself that what I was about to say had been published in the AMSAT-NA Symposium journal or elsewhere.

I think that one of the most interesting conversations we had was when my friends were discussing some of the lessons that they had learned from VO-52. For a number of reasons, both political and practical, they used a special command and telemetry link that operates outside the ham bands. There is nothing aboard the satellite except the ham payload, and there is nothing secret there. However, because of this non-ham channel, all the command and telemetry traffic had to be handled on a request basis by ISRO. And that means that even AMSAT-India did not really have day-to-day insight into the health of the satellite. They had

to make special arrangements to get telemetry or uplink commands. VO-52's demise was as big a surprise to them as it was to us. If they have another chance to fly they certainly hope to use ham bands for telemetry not only so AMSAT-India can have more control, but also to get the benefits of a global community of telemetry collectors!

I also got a tour of Nitin's antenna farm on the top of his apartment building. He lives on the top floor, so he has easy access; there are no local zoning restrictions on antennas, and he has good relations with his neighbors. Nitin has plans for a full two-axis rotator setup complete with 2M, 70cm, and S-band dish, but for the moment he is relatively limited with a 1-axis azimuth rotator. That does not stop him from collecting an enormous number of QSL cards for telemetry from satellites built around the world!

That tour brought my visit to an end, so I said farewell to Nitin, Mani, Bopana, Amal, and to India as I headed off to the airport for my long flight home to FN42.

My thanks to Nitin for hosting this fun meeting and to Mani, Bopana and Amal for giving up part of their afternoon to have an eyeball QSO with a ham from the states! Nitin asked me to convey that he is conveniently located near the Bangalore International Airport (BLR), and he would love to see other hams who might be in Bangalore. My personal suggestion is that it is very convenient to arrange with Nitin to meet a few hours before your flight leaves from BLR. Then when you are arranging your airport transportation hire a bit of extra time from your ride (taxi, hotel car, whatever). Your driver can then wait for your outside of Nitin's QTH and be ready to leave for the airport whenever you are ready. Don't be concerned about the wait time; it is very normal practice.

Even if you never get to India, be on the lookout for chances to visit fellow hams when you are in their city, state, or country! Hams worldwide are a friendly bunch, and the chance to see a person whom you only know as a call sign or an email address is priceless!

AMSAT INDIA

http://amsatindia.org/

Left to right - Bopanna, VU3BOP; Mani, VU2WMY; Nitin, VU3TYG; Burns, W2BFJ; Amal, VU2GDX.

Nitin, VU3TYG

Burns (holding an experimental cubesat board), Arjun, and Amal, VU2GDX.

Arjun with his school project

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

We need volunteers with a commitment to deliver in the design and construction of our satellites, "keeping amateur radio in space"!

- Thermal design
- Power systems design
- RF systems design
- Internal Housekeeping Unit (IHU) systems, command, and control hardware
- IHU software design and development: Especially SDR and DSP
- PC board layout and construction
- Systems Engineering
- Test planning and system testing
- Mechanical design and construction
- Ground station software development

Send an e-mail describing your area of expertise and experience to Jerry Buxton, N0JY at: n0jy@amsat.org. Please include your AMSAT member number..

AMSAT Publications

AMSAT has immediate needs for volunteers to help with publications on the web, weekly bulletins, and printed materials.

- Join the AMSAT News Service (ANS) team as a weekly editor on a rotating basis.
- Be an assistant Editor for the AMSAT Journal magazine developing and publishing print articles on amateur radio in space.
- Graphics and photo editor

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