

The
AMSAT®
 Journal

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Volume 40, Number 5

September/October 2017

Affordable and Versatile SDR



[Images courtesy of rtl-sdr.com, itead.cc, and sdrplay.com]

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**See our review, QST March 2016 page 60.*

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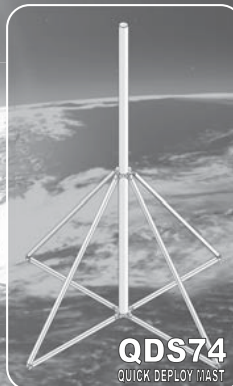
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AMSAT Announcements

2017 AMSAT Board of Directors Election Results

As a result of the 2017 Board of Directors Election, Drew Glasbrenner, KO4MA, Jerry Buxton, N0JY, Paul Stoetzer, N8HM, and Clayton Coleman, W5PFG, will serve on the board for two years.

The Alternate is Peter Portanova, W2JV. He will serve for a term of one year.

The results of the voting with 695 ballots cast are as follows:

Drew Glasbrenner, KO4MA.....626
Jerry Buxton, N0JY.....610
Paul Stoetzer, N8HM.....509
Clayton Coleman, W5PFG.....503
Peter Portanova, W2JV.....382

Submitted by:
Martha Saragovitz, Manager
Paul Stoetzer, Secretary

AMSAT's Mission

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

AMSAT's Vision

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



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AMSAT-NA Senior Officers

President: Barry Baines, WD4ASW

Executive Vice-President: Joe Spier, K6WAO

Treasurer: Keith Baker, KB1SF/VA3KSF

Secretary: Paul Stoetzer, N8HM

Manager: Martha Saragovitz

Vice President, Engineering: Jerry Buxton, N0JY

Vice President, Operations: Drew Glasbrenner, KO4MA

Vice President, User Services: Open

Vice President, Human Spaceflight: Frank Bauer,

KA3HDO

Vice President, Educational Relations: Joe Spier, K6WAO

Honorary Positions

Immediate Past President: Rick Hambly, W2GPS

President Emeritus: Tom Clark, K3IO

Founding President: Perry Klein, W3PK

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Advertising Office: AMSAT-NA Headquarters, 10605 Concord St., Suite 304, Kensington, MD 20895-2526, Telephone: 301-822-4376.

The AMSAT Journal (ISSN: 1407-3076) is published bi-monthly (Jan/Feb, Mar/Apr, May/Jun, Jul/Aug, Sep/Oct, Nov/Dec) by AMSAT-NA, 10605 Concord St., Suite 304, Kensington, MD 20895-2526. Telephone: 301-822-4376, fax: 301-822-4371. Periodicals postage paid at Kensington, MD and additional mailing offices.

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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 JPG 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.

Apogee View

Barry Baines, WD4ASW President

September is always a busy month as summer ends, schools reopen, football season starts, and the transition to fall begins. In the first two weeks of September, I had the opportunity to interact with AMSAT members at two different venues. Over the Labor Day weekend, John Kludt, K4SQC and I gave an AMSAT Forum at the Shelby (NC) Hamfest held at the Cleveland County Fairgrounds, an annual event that celebrated its 61st anniversary this year. Shelby is important because it is the only event where AMSAT currently has a hamfest presence in the Carolinas or Virginia. The weather was perfect for being outdoors, and seeing old friends was great as well. I presented an update on AMSAT programs, and John provided a satellite overview, including information about our upcoming Fox launches. The forum was well attended and included some excellent questions from the audience.

The following weekend (September 9-10) was the New England ARRL Convention at Boxborough, MA, which is the only venue with an AMSAT presence in the six New England states. My first time attending Boxboro (how the locals spell it) was in 2004 when I was living in Concord, NC, and drove up to give a presentation at the AMSAT Forum. After moving to Westborough, MA, in 2006, Boxboro was still an every other year event. Following the 2014 ARRL National Convention (which canceled Boxboro that year), the decision was made to make Boxboro an annual event.

As we did last year, Burns Fisher, W2BFF and I handled the Saturday AMSAT forum at noon where my presentation was similar to the one the prior week in Shelby, and Burns provided an engineering review. This year, AMSAT's presence was enhanced with (1) more forum time on Sunday morning, (2) AMSAT Corporate Secretary and now Board member, Paul Stoetzer, N8HM, giving the keynote at the Saturday night banquet, and (3) more satellite demos. Sunday's forum was one hour longer, allowing time for a "beginner's forum" by Ernie Bauer, N1AEW, that included taking the attendees outside to watch a satellite demo by Paul, N8HM, working FO-29.

The ability to explain to attendees what it takes to work a satellite, then observe an actual satellite pass, and then go back to the forum

so that Ernie and Paul could answer questions about the demo provided an outstanding opportunity to engage newcomers in learning all about satellite operations. Both the presenters and the attendees were excited about how well this approach worked, and it made a huge improvement in our ability to explain satellite operations. What made this possible was having a long enough forum time in the morning to allow at least one satellite pass to occur during the forum, and then having the satellite operator be prepared to do the demo. Indeed, during the weekend we had at least two satellite operators giving demos (Bob, KB1SWZ also worked the FM sats), which further built interest. The AMSAT booth was well-staffed, and we sold out of both the Getting Started Guide and laminated frequency charts while taking in seven new members and five renewals. It was a good weekend for AMSAT.

As I write this column in mid-September, I'm reaching a milestone: if I've calculated this correctly, this is my 49th (and final) "Apogee View." First elected as President by the AMSAT Board of Directors in October 2008, I'm completing my ninth term as President.

I've also reached another milestone. As I recall, I was first elected to the AMSAT Board of Directors in September 1999, and I attended my first board meeting as a voting member in October 1999 when the AMSAT Space Symposium took place in San Diego, CA. The San Diego meeting was memorable because Qualcomm (based in San Diego) was testing their Globalstar LEO satellite communications constellation, and the attendees were invited to make free phone calls back home via satellite from the Symposium during the testing period.

At the time, 44 of the 48 Globalstar satellites in orbit underwent systems tests. I took advantage of the opportunity to make a call back home to Jacksonville, FL, and spoke with my XYL (Kathy, WD4ASX), which was also her first experience conversing via a commercial satellite system. Globalstar subsequently entered service in 2000. Like many service innovations, Globalstar was subject to changes in the marketplace and economics. However, it survives today with plans to launch a new generation of satellites. As Globalstar has evolved and adapted to new circumstances and challenges, AMSAT has likewise changed over the years in response to external opportunities and conditions beyond our control, as well as the dedication of many of our volunteers and leaders who have made a great impact over the years.



It is now fall 2017, and after 18 years (9 times elected by the membership for a two-year term) of serving on the board, I'm not a member of the new board that is now in place following the announcement of election results on September 15. Two new voting members were elected: Clayton, W5PFG, and Paul, N8HM (filling the vacancy created by Bob McGwier, N4HY, who also declined to seek reelection), both of whom served previously as alternates, and a new alternate, Peter, W2JV. I'm excited that the new board will benefit greatly from these individuals' insight, enthusiasm, energy and commitment to move AMSAT forward. "Succession Planning" is an important part of managing the future of any organization and includes providing a way to bring the next generation into leadership positions. They join a strong team consisting of three members elected in 2016 for two-year terms - Tom Clark, K3IO, Mark Hammond, N8MH, and Bruce Paige KK5DO - and the reelection of Jerry Buxton, N0JY, and Andrew Glasbrenner, KO4MA.

At the upcoming board meeting in Reno on October 26, the board will elect a new President. Nine years as President of AMSAT has been a high honor and privilege. I appreciate the focus and dedication of our senior leadership team, and the scores of volunteers that they work with, to move the organization through the trials and tribulations, while also creating the outstanding successes over the years. Nine years is a long time to lead an organization, and now is the time for new leadership with the energy, focus, and vision to deal with the challenges that face AMSAT today.

As I've repeated over the years, "Keeping Amateur Radio in Space" is the vision that keeps us focused. However, how we meet that commitment has evolved considerably during my watch.

That evolution is reflected in the 2009 decision to build 1U CubeSats with the basic FOX design that subsequently has proven itself, with the expected launch of four Fox-1 class satellites in the next six months. AMSAT VP-Engineering, Tony Monteiro (SK), noted the limited resources available to AMSAT at that time to build and launch amateur satellites. He convinced the AMSAT board in 2009 that partnering with universities having researchers interested in flying scientific payloads would justify to NASA covering the launch of amateur radio satellites; the scientific value met NASA mission objectives. Fox-1A (AO-85), RadFXSat-1/Fox-1B, and RadFXSat-2/Fox-1E are on ELaNa launches because of the science as well as student involvement in these projects.

I remember in March 2014 when Tony's health was failing, and we considered the possibility that we'd need to find a new VP-Engineering, I started asking around for recommendations, and the only name suggested to me was Jerry Buxton, N0JY. As recounted in the March/April 2014 issue of *The AMSAT Journal* (p. 24) Joe Fitzgerald, KM1P, recalls Tony's reaction, "While we did not discuss specific titles, Tony was enthusiastic about the idea." I told him, "We made Jerry point man for engineering."

"Well, he IS the system engineer. He'll do fine," said Tony, citing Jerry's long experience with the railroad. I remember this well because Tony's response was typical Tony. I also remember it well because I was in Texas on March 26, 2014, visiting family and had lunch that day with Jerry to discuss some matters of which Jerry was unaware concerning Engineering. Ten minutes after Jerry dropped me off at my son's home, I was notified of Tony's passing by his family.

Tony's assessment of Jerry was certainly correct. Later that spring, I was honored to give the eulogy for Tony at his memorial service at the North Parish of North Andover Unitarian Universalist Church in North Andover, MA, noting that amateur radio is an area where Tony made a significant difference to people throughout the world.

An interesting evolution of the Fox program is that universities are coming to AMSAT to establish relationships because they see that AMSAT is a viable partner. For example, we're starting to see situations where a university wants to incorporate our space hardware into their satellite design. Consequently, the University of Washington will utilize our linear transponder design in their upcoming CubeSat mission. This is a great example of "putting an OSCAR into every CubeSat" approach. Congratulations to AMSAT VP-Engineering Jerry Buxton, N0JY, for developing this opportunity to expand amateur radio in space.

Our coming to grips with ITAR in 2008-2009 cleared the way for our engineering volunteers to dedicate their time and effort on future satellites with a new appreciation of what is required to "play in space." I wrote a paper for the 2010 Proceedings of the AMSAT Space Symposium, "AMSAT and ITAR: Lessons Learned," that outlined the steps AMSAT took under the ITAR self-disclosure process that allowed our volunteers to continue their engineering work with AMSAT without concerns for past "sins." I also provided a presentation at the 2010 AMSAT-UK Colloquium that explained

how ITAR impacted AMSAT-NA's ability to collaborate on international projects.

The successful deployment of ARISSat-1 in August 2011 from the ISS opened the door to using Software Defined Radio (SDR) technology in amateur radio spacecraft, demonstrating the versatility of a single system to provide a variety of operating modes including slow scan TV, as well as telemetry downloads. The creation of worldwide data collection with forwarding of telemetry from ARISSat-1 to a central server has now been incorporated into the Fox-1 spacecraft with scientific research directly benefiting from the efforts of radio amateurs worldwide to provide data to a central server. I wrote a paper for the 2012 Proceedings of the AMSAT Space Symposium that summarized the significant benefits of ARISSat-1 on educational outreach as well as general amateur radio impact as documented by those that collected SSTV imagery and telemetry packets ("An Overview of the ARISSat-1 Mission").

ARISS (Amateur Radio on the International Space Station) has evolved considerably in the past few years, responding to a variety of new challenges and relationships. SAREX (Shuttle Amateur Radio Experiment) was started in 1983 with the flight of STS-9 and Owen Garriott's first onboard use of amateur radio from space. SAREX established the viability of placing amateur radio assets on human spaceflight platforms and was the precursor of expanded opportunities that a space station could provide. ARISS was established in 1996 before the first International Space Station segment was placed in orbit to establish a formal relationship between amateur radio organizations and the space agencies managing ISS. Amateur radio equipment already was onboard the ISS before the first crew arrived in November 2000.

Now, 20+ years after the establishment of ARISS, amateur radio presence continues on the ISS. However, in today's environment, AMSAT now is taking an even bigger role than before in leading ARISS. ARRL continues to support ARISS. However, with the departure of the ARRL's Debra Johnson, who served as the ARISS Education leader, ARRL HQ staff are no longer directly engaged in the day-to-day leadership of U.S. activities with ARISS. AMSAT VP-Human Space Flight, Frank Bauer, KA3HDO, leads ARISS-International, the body that serves as the voice of amateur radio to the space agencies regarding both the operational and technical aspects of amateur radio's presence onboard the ISS.

Rosalie White, K1STO, continues as the



ARRL international delegate to ARISS. She temporarily has volunteered to lead a team of ARISS volunteers from AMSAT and ARRL who now are engaged in school selection after review of submitted proposals, providing educational guidance to the schools in preparation for their contacts, and documenting the impacts of those contacts.

An added responsibility is finding the funds to support the costs of keeping ARISS sustained and thriving. Such costs include the development of new onboard hardware systems used for school contacts and by hams on the ground. The fundraising effort led to new relationships with CASIS (Center for Advancement of Science in Space), which manages the ISS U.S. National Laboratory. CASIS provides co-funding to help underwrite ARISS management costs that include salary for the mission control contractor at Johnson Space Center who coordinates the scheduling of contacts with the ISS operations managers. Frank has also secured funding from SCAN (Spacecraft Communications and Navigation) at NASA HQ to co-fund the mission control contractor to keep ARISS going. Along with funding support, however, is the necessity of documenting the benefits generated by that support. The results of that funding support must be documented according to administrative requirements to meet our benefactors' needs.

Meanwhile, ARISS is making plans to develop and deploy the next generation of amateur radio systems on board the ISS to replace aging and failing equipment. The replacement of failed equipment is critical but also time-consuming and expensive; like any system to be placed on the ISS, new radio systems must meet NASA safety certification standards. This requires more funding for hardware development and safety certification.

I continue to be impressed by the dedication, ingenuity, and technical tenacity of the ARISS-US team as they tackle an ever-changing environment. The overall impact of ARISS on students and educators at all levels is remarkable. ARISS contacts at schools and other venues put amateur radio on center stage, not only showcasing the technical aspects of our hobby, but demonstrating to students, teachers, and family/friends that amateur radio today plays a critical role in support of the ISS and builds goodwill within their communities. Just as important, an ARISS contact can provide the spark to encourage students to pursue their interests in STEM, which in turn can potentially translate into interests in wireless communications and

sometimes amateur radio.

We cannot quantify the overall impact of ARISS contacts on students as they matriculate to higher education and careers. We do know that the immediate "wow" impact on students taking part in an ARISS contact coupled with the pre- and post-contact educational experience do create the potential for long-lasting educational benefits, as well as encourage family/friends and educators to support those aspirations.

The ARISS of today is the result of a variety of relationships that Frank and his team have nurtured to keep the program going as well as the dedicated efforts of many individuals that support ARISS as volunteers who happen to be AMSAT members as well. I take pride in the fact that the AMSAT Board of Directors and the Senior Leadership Team, despite the ever-changing financial and operational circumstances, have served as a bedrock of support for ARISS. While the program depends upon a multitude of individuals and relationships, AMSAT has remained steadfast in support of amateur radio's relationship with human spaceflight. The human spaceflight program that started under the leadership of Bill Tynan, W3XO, in the early 1980s continues 35+ years later in response to changing circumstances and opportunities.

The announcement I made at the 2017 Hamvention during the AMSAT Forum that the U.S. Air Force Academy satellite FalconSAT-3 will be utilized as an amateur radio satellite finally has happened. ANS-267 on September 24 provided the details. This news is outstanding for both amateur radio and AMSAT, reflecting the A.F.A.'s desire for FS-3 to have a new communications mission and to collaborate with AMSAT. I'm thrilled as I leave office that another satellite is now available for amateur use as we await the launch of AMSAT's four Fox-1 class satellites later this year and into 2018.

Administratively, AMSAT continues to evolve and develop services in response to changing membership expectations. *The AMSAT Journal* is a key member benefit and under the leadership of editor Joe Kornowski, KB6IGK, the *Journal* is being published on time every other month containing articles developed by our members and the senior leadership team. Before Joe's assumption of the editorship in 2015, JoAnne Maenpaa, K9JKM, served as editor starting in 2012, and before her, Ed Long, WA4SWJ, was the editor. Each of these individuals spent many hours putting together a first-rate magazine. Likewise, the AMSAT News Service under the leadership of Lee McLamb, KT4TZ,

continues to provide a weekly release full of useful information that helps to bind together the worldwide amateur satellite community.

One of the lessons learned over the past nine years is that, with a mission-critical requirement, it probably makes sense to put \$\$\$ resources into it to ensure completion. While we take great pride in the volunteer nature of AMSAT, limitations regarding how well volunteers can focus and produce results when there are significant time constraints can limit self-motivation. Volunteers define their priorities and how much time they will spend on volunteering. They have family and job responsibilities that take higher priority. One cannot "fire" volunteers because, by definition, they are not employees. That means AMSAT cannot require a volunteer to focus more time to complete tasks by a stipulated deadline. Volunteers continually come and go as circumstances and interest dictate, meaning that we must continually look for talent to fill the gaps when someone is no longer available.

An example of a project not getting done is in the area of Information Technology (IT). For years (as I recall, going back to 2004) we've been trying to create a new membership database system to replace the one that Tom Clark, K3IO, created using dBase III in the early 1980s to run under DOS. The new database could become the basis for managing a members-only website as well as enhance our membership management processes. Over the years, we went through various fits and starts, but in each instance, progress stopped at a certain point. The reason was that developing such systems is real work done by competent people requiring significant working hours. Those people's day jobs were very similar to their volunteer efforts. It wasn't fun for them, and other priorities took them elsewhere.

In 2016, Joe Fitzgerald, KM1P, recommended that AMSAT retain a professional IT firm. The firm's task would be to: (1) develop a membership database, a new website structure to replace the "temporary" website that replaced the former one that was hacked in February 2013; and (2) create a new online AMSAT Store with better security and a better shopping experience for users. Joe's recommendation was, instead of depending on volunteers, to spend the money to get the job done under a contractual relationship with project definitions, milestones and product goals. The board accepted his recommendation and allocated funds for the development effort. The initial results are evident in the new AMSAT Store and the new AMSAT website that went into service over the summer. The AMSAT membership



database is still evolving, and I'm hopeful that it will be fully operational by the end of 2017. Once it is fully functional, the AMSAT leadership can consider how best to develop a members-only website capability, as well as determine how to implement electronic publishing.

I see similar trends in paying for someone's time to focus in those areas with significant deadlines and a substantial workload. For example, as we become more engaged with outside organizations that could provide funding support for AMSAT programs, they will want AMSAT to provide metrics and reporting of significant developments on a weekly or monthly basis. Paying for the services of someone to handle these tasks would make sense. In certain situations over the years, we've also paid individuals to complete satellite systems to meet testing or delivery deadlines. As we move forward, I wouldn't be surprised to see a growing trend towards paying for individuals to dedicate their time and effort to produce a quality product by stipulated deadlines.

Of course, the ability to cover such expenses is dependent upon AMSAT having the necessary resources. Expanding membership to cover administrative and operational expenses related to maintaining AMSAT's presence is important, but so is raising funds for the projects that we want to build.

What about the future? I'm confident that the successes of the past nine years that I served as President will lead to new opportunities in AMSAT's future. Our university relationships developed under the Fox program are strong and could lead to future collaboration. The ASCENT program is developing innovative technology that could be used in a variety of projects. Our relationship with Ragnarok Industries as it pursues NASA's CubeQuest Challenge has resulted in serious engineering development work applicable for future opportunities. Our collaboration with Virginia Tech on the Phase 4-B project has created new relationships that hopefully will lead to new opportunities for geosynchronous orbiting amateur radio payloads despite the travails of the host payload that has significantly delayed their project schedule. A key benefit has been incorporating SDR into the payload development and the resulting ground station design — work that has potential application in a variety of scenarios. I cannot predict the future, but I do know that AMSAT's volunteers will be positioned to take advantage of opportunities that may arise because of the relationships that have been established within industry, NASA, educational institutions and the amateur radio

community.

AMSAT has been a significant part of my life since I joined in 1983 and assumed an initial leadership role as Director-Field Operations in 1992 that later led to serving as VP-User Services (2004) and then VP-Strategic Planning (2006) before becoming President in 2008, as well as serving on the board since 1999. I've had the pleasure of working with some impressive people inside of AMSAT as well as the broader amateur radio community over the years. Whatever accomplishments have been achieved during my time as President have been the result of dedication, hard work and the vision of the entire AMSAT team.

In closing, I also wish to extend my thanks to Martha Saragovitz, AMSAT's sole employee who also serves, along with Tom Clark, K3IO, as our "corporate memory." Martha will reach 40 years of service with AMSAT this January, a phenomenal accomplishment. She started as an administrative assistant in January 1978 and has seen it all through the years. While she's not licensed by the FCC as an amateur radio operator, she is probably more qualified as a communicator with amateurs than anyone else. She is the "voice of AMSAT" as she speaks with one and all via the AMSAT phone line. She sees old friends every year at Hamvention and the AMSAT Space Symposium. She helps coordinate and execute the plans for the Space Symposium and AMSAT's presence at Hamvention each year. She serves as a centralized conduit since she talks with everyone. To many of our members, Martha represents AMSAT with her day-to-day presence.


Much of the work that must be done to keep AMSAT moving forward on a day-to-day basis is done by Martha. During her work day she processes AMSAT Store purchases, new memberships and renewals, pays the bills, prepares budgets (under the guidance of AMSAT Treasurer Keith Baker, KB1SF), works with the accounting firm to prepare for our Annual Review and submission of our Form 990 and 990T tax returns, ships boxes of items to our volunteers handling various hamfests, and otherwise keeps things moving on an administrative basis. Her attention to detail, particularly with financial records, is extraordinary. Every month the checkbook is balanced to the penny, the QuickBooks Reports are complete and balanced, and the accountant continues to rave about how thorough her preparation of our financial records is.

For the past 25 years after I became Director-Field Operations I've interacted with Martha

in a variety of areas. Her writing skills and thorough grasp of grammar and punctuation are extremely helpful to me as I ask her to review my drafts of articles for the AMSAT Journal and critical letters (she'll be reading this before you do, and I trust she won't be upset by my recognition of her considerable impact). I've come to depend upon her common sense and sensitivity to how others might respond to my formal writing and comments. Over the years, she's seen changes that might be initially viewed as threatening, but she realizes that we (AMSAT) can influence our future and that she and AMSAT can adapt to changing circumstances. At some point, she usually recognizes that it is possible to survive new ways of doing business and that, generally speaking, the change is for the better.

Since I won't be President in January when her service anniversary takes place, I'm taking this opportunity now to thank Martha for her support and dedication to AMSAT over the past 40 years and for making my various roles within AMSAT more successful for the past 25 years. She is someone who cares deeply about the organization and those who are part of it. Martha, thank you.

Over the past couple of months, I've commented to friends, "I now want to play amateur radio rather than manage amateur radio." With that thought in mind, I'm looking forward to getting my satellite station built in Folkston, GA (the antennas have been sitting in my garage in Folkston in original packaging since 2012). It'll be fun to have time to scan the HF and satellite bands remotely when I'm not in Folkston or to spend time working on my 3-rail train layout that will be in Keller, TX (our primary residence), or to watch CSX trains provide the entertainment as they pass by the house and the ham station in Folkston.

Thank you all for the support that you have extended to AMSAT and me during my tenure as President. Hopefully, in the not too distant future, I'll be able to see you on the birds! 



Introduction to RTL-SDR: Ultra Cheap Software Defined Radio

Carl Laufer

[From the TAPR Forum, Hamvention 2017]

The RTL-SDR dongle is essentially an ultra-cheap software defined radio. For the last few years, I've been running this blog called rtl-sdr.com, and what I've been doing is collecting stories related to ultra-cheap software defined radios like the RTL-SDR and, more recently, HackRF, Airspy and SDRplay.

What I've also done is started the sigidwiki, a community-run wiki that is a collection of signals and sounds. So, if you don't know what a signal is on a spectrum, you can go there and try to look it up, and see if it matches anything. More recently, I've also been working on the basic RTL-SDR dongle to try to improve its performance.

The RTL-SDR dongle is just a really cheap RX-only software defined radio, and it has a tuning range from about 24 MHz up to about 1.7 GHz. You can get about 2.4 MHz of bandwidth. Originally, these things were designed as a DVB-T tuner. In America, we don't use the DVB-T. So, if you don't know, it's the free to air TV standard that is used in most of the world apart from the United States. And, so, of course these things are really popular because people want to watch TV on their laptops and small devices.

These things are really heavily mass-produced in China and so, the cost, if you went to the factory and you wanted to buy, say, ten thousand of these basic units, you would probably be paying something like five or six dollars for 10,000 units per unit. And so that means they must be getting produced for something like two or three dollars.

This all came about through some hardware hackers. I think they were trying to write drivers, TV drivers for Linux, and then they discovered this SDR feature, which was built on RTL2832U chips that are used on these RTL-SDR dongles. They found that it was a lot more versatile than they first thought and discovered that they could tune up from about 24 MHz to 1.7 GHz. So, once these things started becoming popular, I think it opened up a whole new world of radio experimentation for people who normally

wouldn't be interested in radio, such as myself.

Four years ago, I purchased my first RTL-SDR dongle, not really knowing what it was, and today I'm really interested in radio. And it also helped bring back a lot of old blood to radio, too. I keep getting emails and messages from the people who say it's reinvigorated their interest in the radio scene.

As I mentioned before, one thing I did was redesign the RTL-SDR, and this is the model that I redesigned. There were some problems with the generic dongles. First, the oscillator was just a really cheap one, so as the PCB started to heat up, the frequency was very unstable. There was no shielding, and it was full of spurs. And also there were problems with L-band reception at about 1.5 GHz due to overheating problems. It also used a very annoying MCX RF connector, which is not very common at all. So, what I did for the V3 was to work with the factory in China to improve these faults with the generic dongles. I just changed oscillator to a TCXO, which is a temperature compensated oscillator. That makes it very stable. I added a metal case for shielding. I redesigned the PCB to get rid of some of the spurs and lower the noise floor. I fixed the overheating problem on L-band and added a thermal pad, which wicks away the heat from the PCB and uses the metal case as a heat sink. I also changed the MCX connector to an SMA connector, which is a lot more common, of course. I also added some extra features for people who want to use a bias-T, people who want to put an LNA by the antenna and add power through the coax cable. And I also added HF reception down to about 500 kHz using direct sampling.

If you go on eBay or Amazon, you're going to see a lot of different types of RTL-SDR dongles on the market. The one I designed costs about \$25 U.S. on Amazon, and the generic ones with the CD and the remote anywhere between about eight to \$10. And if you are paying more than that, then you're probably getting ripped off. And there's a lot more variety, such as these very small 1 cm by 1 cm x 16 mm models, and those are great for things like Android phones and mobile devices.

You want to set up an RTL-SDR, I'm not going to go into detail. To set one up, you can go to the website, and the Quick Start guide, slash QST. Yes, it is not plug-and-play, but it's pretty easy to set up. You just download a software program, unzip it, double-click on the program, install the drivers, and you should be good to go. If you are familiar with

Windows, unzipping files, and things like this, then you should be okay to set one up.

Of course, you can also use it up on Linux and Raspberry Pi, Android, MacOS. On Windows, you have some options like SDRsharp, SDR-Console, HDSDR. On Raspberry Pi, you are mainly going to be working with online tools. The newer Raspberry Pis, like the Raspberry Pi 3, can use GQRX, which is a GUI program. And on Linux and MacOS, you have GQRX as well.

On Windows, once you've set it up, such as with SDRsharp, which is one of the free programs for RT, what you have is a waterfall spectrum analyzer. And it's updated with a place where you can tune to the frequency. If you're familiar with this, then know that all you need to do is tune to the signal, set the mode like SSB, and you are listening to it — simple. In the example, I'm listening to the business band in my country, which uses things like trunk radios. This is using voice bands, and the subtle signal in the middle is the trunking channel. You can also decode trunking channels and follow conversations with RTL-SDR dongle.

I am just going to talk a bit about some of the applications and give you an overview of what you could do with some of these \$10-20 dongles. And there are many applications, and I can't cover them all here. But the slides below show some of the diverse applications.

If you're interested in digital voice monitoring, like P25 and DMR, there is a free program out there called DMD+ that you can use with a RTL dongle to decode these digital modes. Of course, you can only listen to unencrypted conversations. There is also another version, not DSD+ but a different version that can be used to decode D-STAR, used by amateur radio on VHF. And, as I explained before, if you want to listen to trunk radio conversations, you can use a program called Unitrunker and two RTL dongles. One dongle will be used to listen to the control channel, and the other will be used to tune to the voice channels.

I want to give an example of how you can set up a remote monitoring station with a Raspberry Pi 3, a RTL dongle, ADS-B filter and an antenna, powered through the Internet. What you can do is set one of these up on the roof of your house or the roof of your apartment building, and connect to it remotely via Wi-Fi or Internet cable. And you can use software called RTL_TCP. Or there is a new and better one called SpyServer, which can be used for the same



purpose. But for these programs, you need a decent network connection. The only way you can do this is on a local network with Internet or local Wi-Fi N or something like that.

If you wanted to share your receiver over the Internet, there's software called OpenWebRX, which enables Internet connections from all over the world to connect to your RTL dongle and stream from that dongle over the Internet. If you want to go and see some examples of people were connected RTL dongles to OpenWebRX, you can go to SDR.hu, and you'll find a list of people who are sharing their dongles.

This is very smooth over the Internet. I just have DSL. This is very efficient to use over the Internet. Other programs like RTL_TCP and SpyServer send the raw data, which is why it uses a lot of bandwidth.

One application that is very commonly used with RTL-SDR is ADS-B, which stands Automatic Dependent Surveillance-Broadcast. Most planes these days carry onboard an ADS-B transponder, which broadcasts the GPS position of the aircraft (Figure 1). This signal is completely unencrypted, and if you have RTL-SDR, you can receive the signal and plot on the map the position of the aircraft around you. There are many actual commercial uses of this type of technology like flightaware.com and flightradar24.com. And these days, RTL-SDR volunteers submit most of the data that is submitted to those websites. These websites aggregate ADS-B data coming in from all over the world submitted by RTL-SDR users, and they use it for their website. So, if you ever use one of these websites to track your flight, chances are some of the data probably came from a RTL-SDR. And, of course, they make most of their money selling their data to airports and aircraft manufacturers.

Another thing you can do is receive weather satellite images (Figure 2). NOAA has three satellites active which are transmitting APT (Automatic Picture Transmission) weather images, and these pass over your location probably once or twice a day. And if you have a satellite antenna, RTL dongle, and run the right software, you can receive images like this. Sometimes the resolution is not that great, but you can really see the weather system that's happening.

It turns out that the Russians have a better satellite, which is called Meteor M-N2 (Figure 3). This satellite is better because

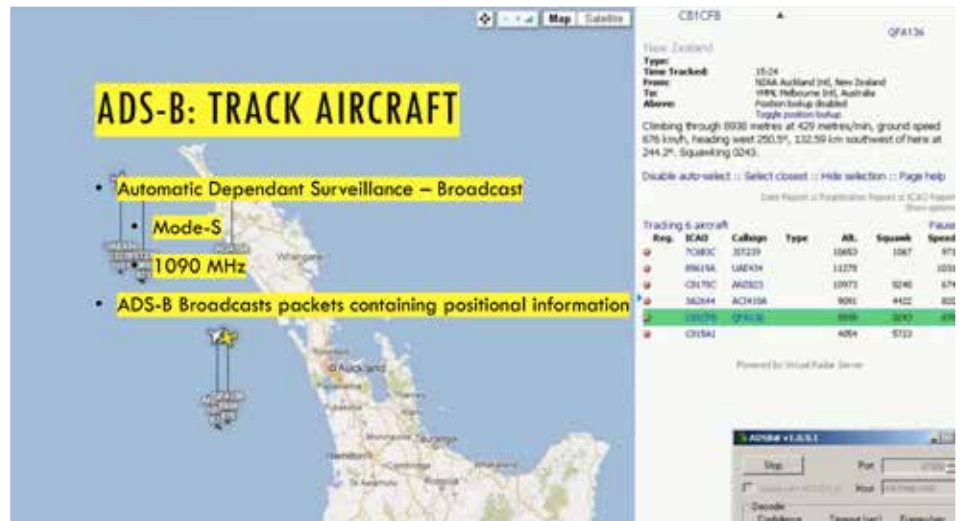


Figure 1 — ADS-B showing aircraft over New Zealand. [All images courtesy of Carl Laufer.]

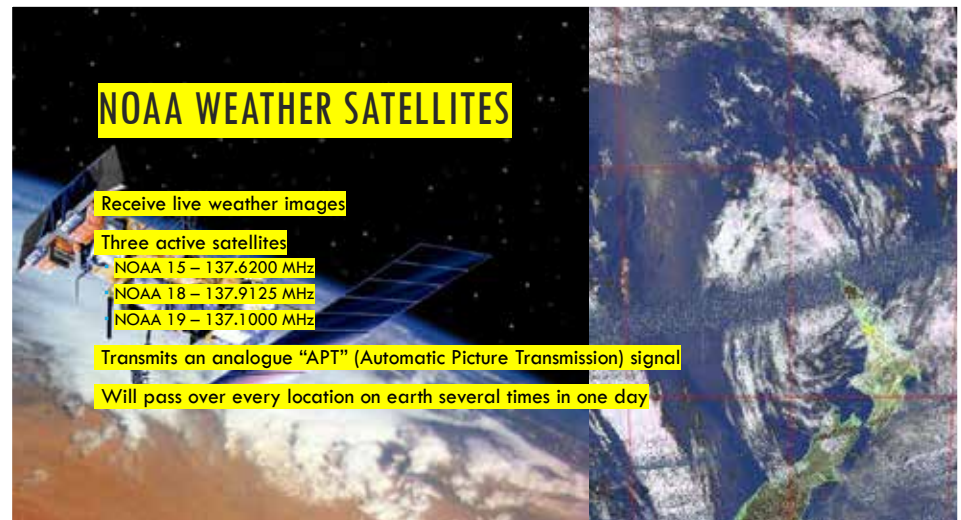


Figure 2 — NOAA weather images received using ADB-S.

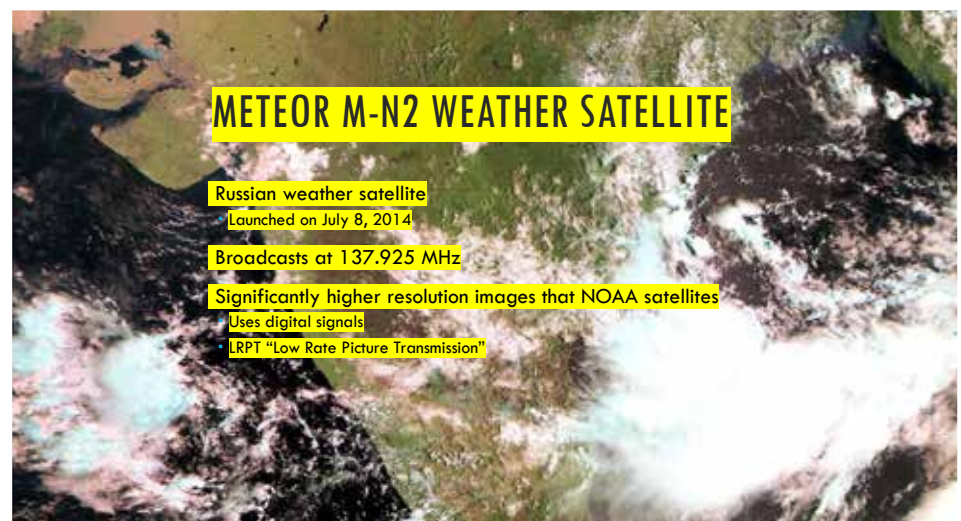


Figure 3 — NOAA weather images received using ADB-S.

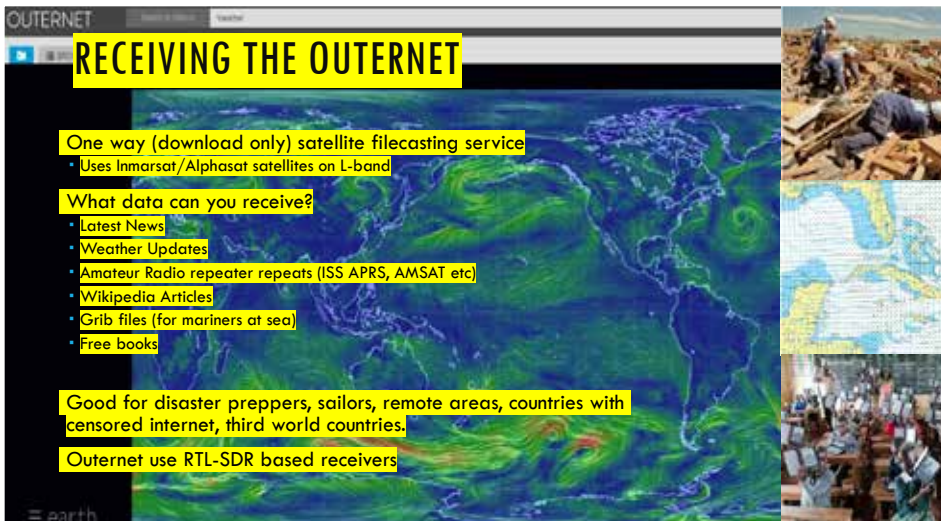


Figure 4 — NOAA weather images received using ADB-S.

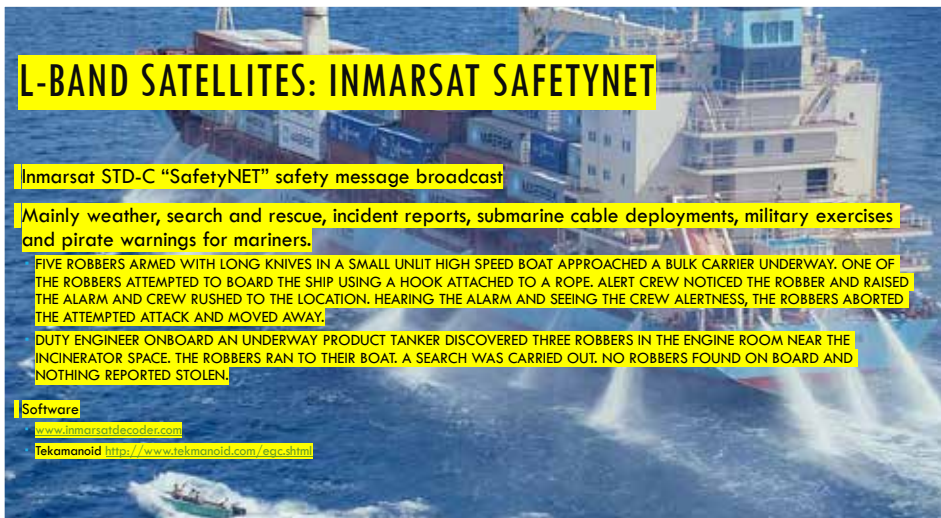


Figure 5 — NOAA weather images received using ADB-S.

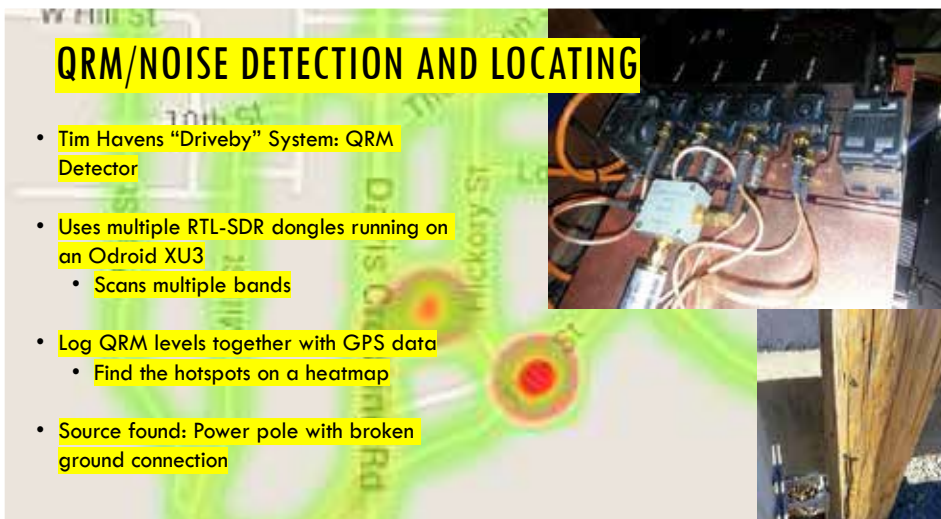


Figure 6 — QRM detection using RTL-SDR with Driveby.

it transmits high-resolution digital images using a signal called LRPT. And, again, you can use a RTL dongle and a similar set up as NOAA satellites to receive these high-resolution images.

Another interesting application that's come up recently is the Outernet (Figure 4). So, let me explain: the Outernet is not the Internet. It's a satellite that is a one-way file casting service. People are using satellites like Iridium and Inmarsat/Alphasat on the L-band, things at 1.5 GHz (Figures 5).

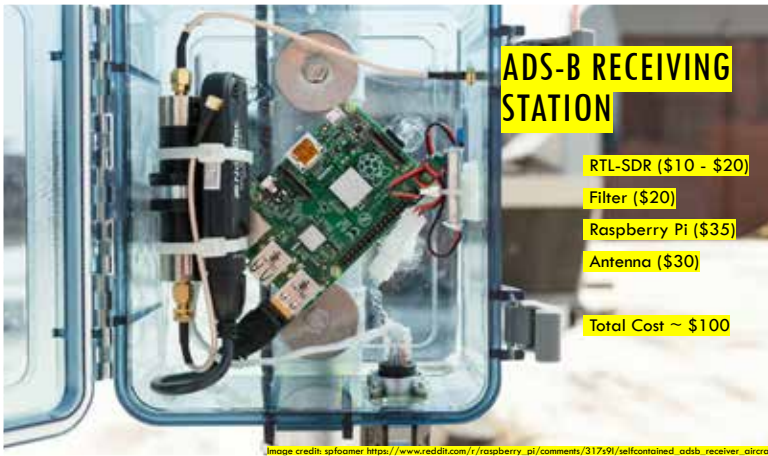
If you are using a RTL-SDR dongle to connect to these satellites, you can receive data like the latest news, weather updates, and they also do repeats of amateur radio repeaters like ISS and the AMSAT satellites. They also send Wikipedia articles, files for mariners that have something to do with weather. Sometimes they also send free e-books.

This type of thing is very good for disaster preppers, sailors, people who are living in remote areas. Perhaps you're in a country with censored Internet or third world country that doesn't have any Internet at all. They use an RTL-SDR system for reception.

A useful application for hams is the detection of QRM or noise and locating where that noise is coming from (Figure 6). Tim Havens, NW0W, created a system that he likes to call the Driveby System, which is QRM detector. In his system, he uses all Odroid, essentially like a Raspberry Pi 3 but more powerful. He connects up of all these RTL dongles to an Odroid, and at the same time he also connects up a GPS antenna. He then puts the system in his car. As he's driving around the streets of his neighborhood, the GPS is collecting the positional data and logging it. The RTL dongles are collecting the frequency data for the QRM levels. So, once he's collected all this data and gets back home, he combines the data into a heat map. Once he finds the QRM hotspots, he can go out to them and try to find out what is causing them. In one case, he found a power pole that had a broken ground connection. He called later to the city council, and he was able to get it repaired, and his QRM was greatly improved.

In conclusion, I'd like to say that RTL is a cheap but highly versatile receiver, and it has hundreds and hundreds of applications. 🌐





ADS-B RECEIVING STATION

- RTL-SDR (\$10 - \$20)
- Filter (\$20)
- Raspberry Pi (\$35)
- Antenna (\$30)
- Total Cost ~ \$100

Additional aviation applications, dead sats...

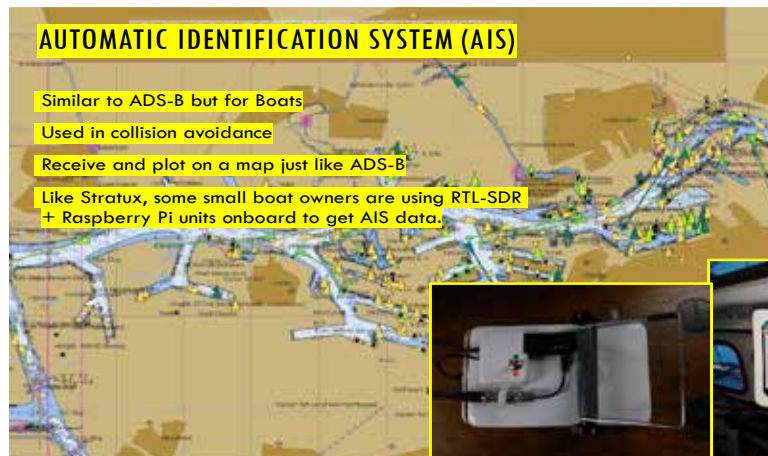


STRATUX

- Small plane pilots are using RTL-SDRs in the cockpit
- Professional ADS-B/UAT equipment costs thousands of bucks
- Stratux costs a few hundred dollars only

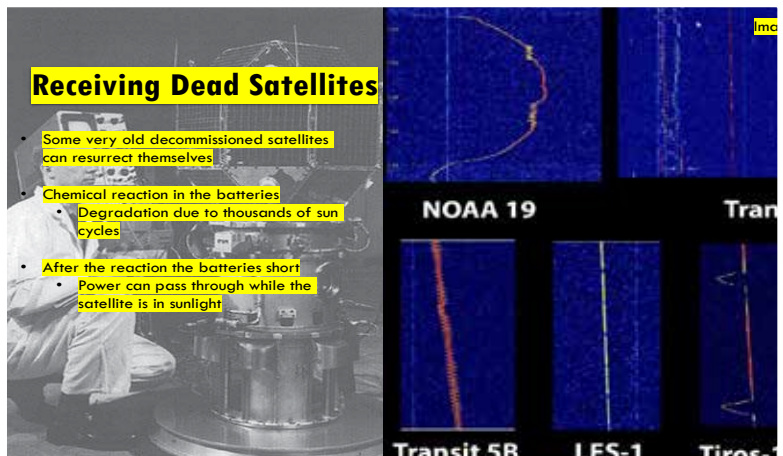
RTL-SDR runs on a Raspberry Pi. Raspberry Pi connects to a tablet which is running navigation software.

stratux.me



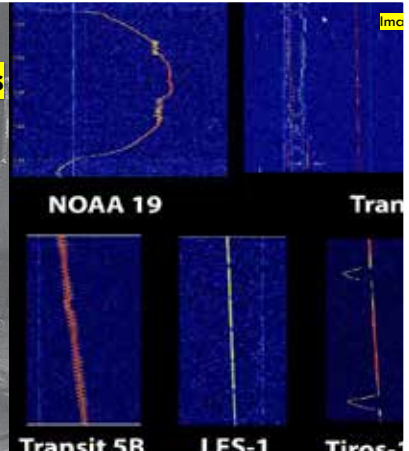
AUTOMATIC IDENTIFICATION SYSTEM (AIS)

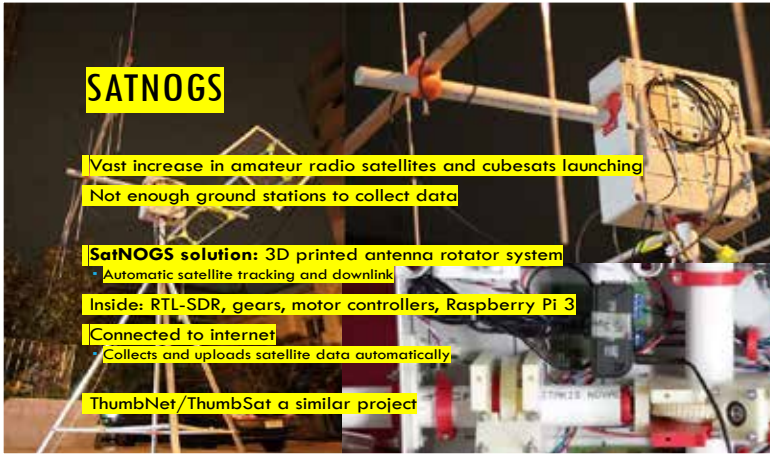
- Similar to ADS-B but for Boats
- Used in collision avoidance
- Receive and plot on a map just like ADS-B
- Like Stratux, some small boat owners are using RTL-SDR + Raspberry Pi units onboard to get AIS data.



Receiving Dead Satellites

- Some very old decommissioned satellites can resurrect themselves
- Chemical reaction in the batteries
 - Degradation due to thousands of sun cycles
- After the reaction the batteries short
 - Power can pass through while the satellite is in sunlight





SATNOGS

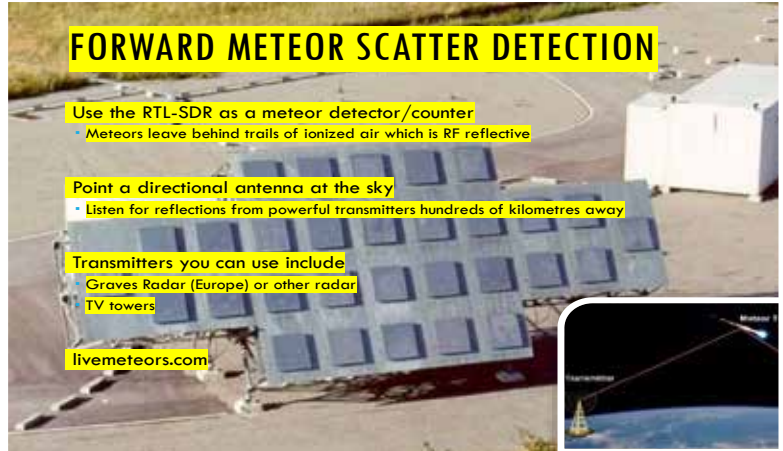
Vast increase in amateur radio satellites and cubesats launching
 Not enough ground stations to collect data

SatNOGS solution: 3D printed antenna rotator system
 • Automatic satellite tracking and downlink

Inside: RTL-SDR, gears, motor controllers, Raspberry Pi 3

Connected to internet
 • Collects and uploads satellite data automatically

ThumbNet/ThumbSat a similar project



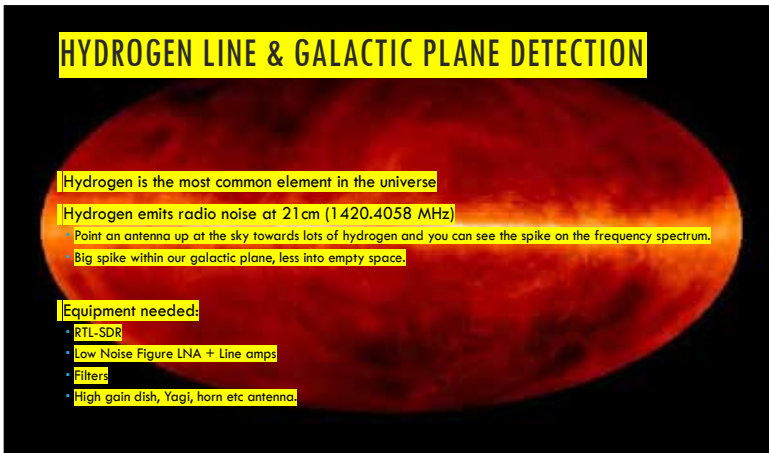
FORWARD METEOR SCATTER DETECTION

Use the RTL-SDR as a meteor detector/counter
 • Meteors leave behind trails of ionized air which is RF reflective

Point a directional antenna at the sky
 • Listen for reflections from powerful transmitters hundreds of kilometres away

Transmitters you can use include
 • Graves Radar (Europe) or other radar
 • TV towers

livemeteors.com



HYDROGEN LINE & GALACTIC PLANE DETECTION

Hydrogen is the most common element in the universe

Hydrogen emits radio noise at 21cm (1420.4058 MHz)

Point an antenna up at the sky towards lots of hydrogen and you can see the spike on the frequency spectrum.
 Big spike within our galactic plane, less into empty space.

Equipment needed:

- RTL-SDR
- Low Noise Figure LNA + Line amps
- Filters
- High gain dish, Yagi, horn etc antenna.

DETECTING PULSARS



Peter East and Guillermo
 Argentine Institute for Research in Space Sciences

- Rotating Neutron Star
- Wideband noise bursts over a wide frequency range
- RTL-SDR Receiver records raw IQ data
- Mathematical algorithms used to detect the pulsar
- neutronstar.joataman.net



An



WHAT DO YOU NEED TO RECEIVE OUTERNET

RTL-SDR v3 or E4000 dongle (with bias tee)

An LNA (with filter)

L-band 1.5 GHz satellite antenna (such as a patch or dish)

C.H.I.P. Computer

Outernet are working on a fully integrated solution

www.outernet.is



Outernet receiver, signal direction-finding app...

SIGNAL DIRECTION FINDING

RasHAWK System

Based on Raspberry Pi's and REDHAWK DSP

Uses antenna switching

Determines the signal bearing

Combine several units to pinpoint the transmitter



12Volt Portable Dual Axis Rotor System

model:
12PRSAT



If you live in an area where you can not have a permanent outside antenna system; or you enjoy operating portable; or you want to do school and public demonstrations; or a little of each; then this Rotor System might be the solution you have been looking for.

Feature Rich and designed to support popular antennas like the light weight Elk Log Periodic to the larger Alaskan Arrow up to the largest supported antenna, being the M2 LEO Pack.



(Optional Universal Mount with M2 Antennas)

(Antenna, feed-line, mast and stand not Included)

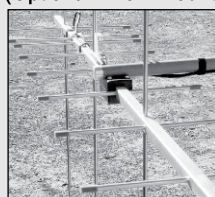
Basic Features Include:

- USB computer interface supporting popular tracking applications (GS--232A Protocol)
- Low Power 12 Volt (12-14VC) operation
- Light Weight and designed for Portable use
- Included Mag/Accel Sensor Module used for fast deployment and tracking accuracy
- Simple to use 3-Button control interface using a single 4 conductor control cable

(Optional Elk Mount)



(Optional Arrow Mount)



(Optional GPS Module)

Portable Rotation

Portable Antenna Rotor and Support Systems
www.portablerotation.com

Email: sales@portablerotation.com
(800) 366-9216 Roseville, CA. USA



A Low-Cost SDR Ground Station for Fox-1 Telemetry

Terry Osborne ZL2BAC

The concept of a low-cost ground station for telemetry reception began as part of the ground station support for the KiwiSAT Project. (See www.kiwisat.org.nz/). That ground station, described below, also supports Fox-1 satellite telemetry capture.

Fox-1 Satellites

The Fox-1 satellites are a series of 1U CubeSats constructed by AMSAT-NA using analog FM transponders that can support science experiments. AMSAT-NA has partnered with universities to develop the science and education experiments. The Fox-1 launches are provided by the universities or by the NASA ELaNa program. (See www.amsat.org/meet-the-fox-project/).

The first of these satellites, Fox-1A (AO-85), was launched on October 8, 2015, by an Atlas-Centaur rocket. Fox-1A's primary mission is to provide a wide-area, amateur radio communications capability that can be accessed using elementary ground station equipment such as a handheld FM transceiver paired with a small, handheld beam antenna. The two science experiments are:

1. An attitude determination experiment using MEMS gyros developed by Penn State University; and
2. A low energy proton detection experiment provided by Vanderbilt University to measure the radiation effects on electronic components.

Fox-1A is in a Low Earth Elliptical Orbit (LEO) approximately 470 km x 780 km above the Earth at 64 degrees inclination. In that orbit, a satellite passes over most locations about eight times daily (Figure 1).

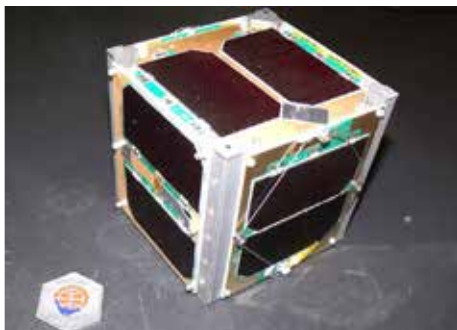


Figure 1.

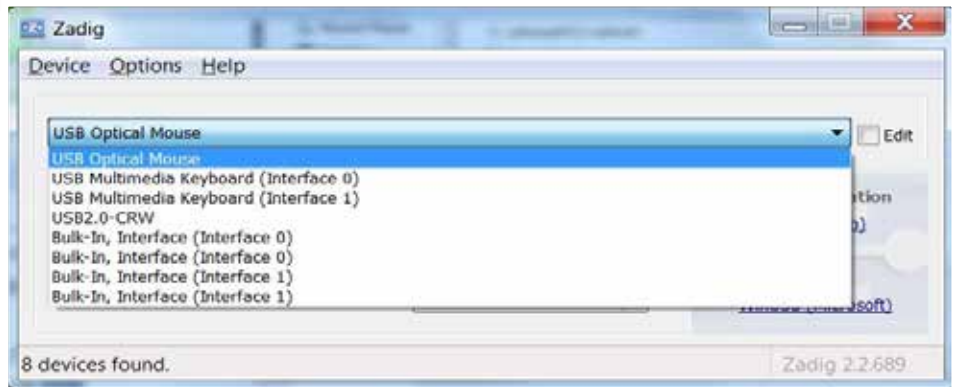


Figure 2.

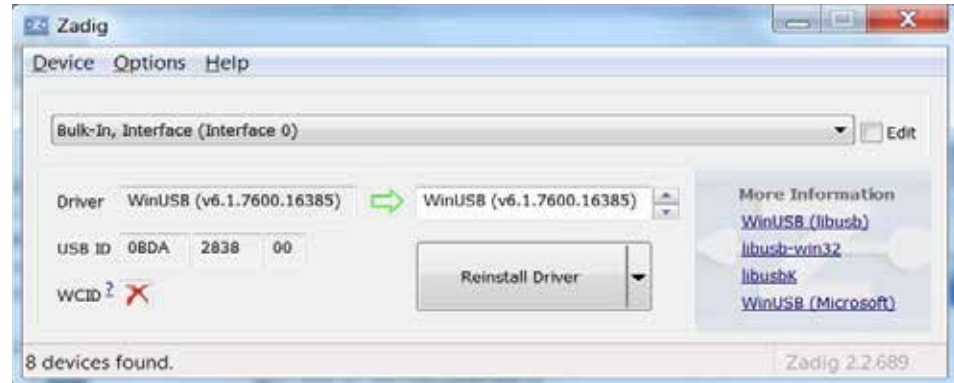


Figure 3.

The second of these satellites, Fox-1B (RadFxSat), is due to be launched on November 10, 2017. The projected orbit is elliptical, 811 km x 440 km at 97.73 degrees inclination. Fox-1B has a FM transponder of identical design to Fox-1A. The science experiments are provided by Vanderbilt University to measure the radiation effects on electronic components. FOX-1Cliff and Fox1D are similar satellites but with an additional camera experiment.

KiwiSAT

KiwiSAT will provide 9600 bps FSK (G3RUH format) telemetry data with 1 W EIRP on 145.865 MHz.

To implement the mission objectives, all these satellites provide downlink telemetry that easily can be received using basic equipment.

Hardware

To receive the telemetry, you will need:

1. A 2 m receiver capable of copying FM transmissions, e.g., RTL-SDR (DVB-T TV tuner dongle and PC or laptop). (See www.rtl-sdr.com/.)
2. A small (3 Element) 2 m beam antenna (3 elements, gain > 6 dBi). (See www.arrowantennas.com/

arrowii/146-437.html and heleggios.net/wb2hol/projects/rdf/tape_bm.htm.)

3. You may be able to receive telemetry with simpler antennas, but this will give marginal results.

You will need a tracking program, such as SatPC32, or Orbitron (all programs referenced Windows applications) to know when the satellite will be available and to control for Doppler effect (see www.dk1tb.de/downloadeng.htm and www.stoff.pl/). Online trackers, such as www.heavens-above.com and www.amsat.org/track/index.php, are excellent substitutes. John Brier, KG4AKV, has produced an excellent YouTube tutorial on how to use heavens-above.com (www.youtube.com/watch?v=V8IWQrtLQyE).

Dongles

The most cost effective way to receive the FUNcube signals is with a RTL-SDR V3 USB Dongle, available from various sources on the net (see, e.g., www.ebay.com/itm/RTL-SDR-Blog-R820T2-RTL2832U-1PPM-TCXO-SMA-Software-Defined-Radio-Dongle-NEW-/142457321694). Other dongles are suitable, including FUNcube Dongle, SDRplay, or KiwiSDR. Having obtained a dongle, you will need to download and install the drivers.



Installing the Drivers

Download the Zadig program from zadig.akeo.ie/. Plug in the dongle and run Zadig. From the "Options" menu select "List All Devices." The drop down list displays the dongle as Bulk-In, Interface (Interface 0; 2 entries; Figure 2).

Select the first Bulk-Interface (Interface 0). Confirm that the WinUSB driver is selected, and install if required. Then proceed to install SDRSharp (Figure 3).

SDRSharp

1. Download the latest version of SDRSharp from sdrsharp.com/#sdrsharp. Currently, this is version 1583.
2. Extract and install SDRSharp from the zip file, which creates a set of sub-directories. Follow sdr-install (1) to sdr-install to sdrsharp.
3. Open the sdrsharp directory and copy all the files to "C:\SDR#." Download the DDE Interface SDRSharp plugin from www.satsignal.eu/software/DDETracker.html. Download

the file DDETrackerV4Binaries.zip. Follow the instructions on the web page. Note that you will now have to edit the file plugins.xml. (See Figure 4). This plugin enables tracking programs such as SatPC32 and Orbitron to talk to SDRSharp and compensate for Doppler shift — a useful feature.

4. The rtl-sdr.dll and the FunCube Dongle dll files are included in this SDRSharp distribution, so either dongle should work.
5. You will need a virtual loopback cable. Download and install from vb-audio.pagesperso-orange.fr/Cable/.
6. To check that SDRSharp is running correctly, run SDRSharp, select RTL_SDR from the Source drop down menu. Select WFM for the Radio setting and tune the frequency to a local FM radio station. You should now be able to hear the station audio from the PC speakers (Figure 5).

Fox-I Reception

The Fox-1 reception settings for SDRSharp are:

Radio: NFM
Filter: Blackman Harris 7
Bandwidth: 16000 Hz
Order: 500
Snap to grid: ticked
Step Size: 10 Hz
Audio Tab: Sample rate 48000 sample/sec (preset)
Input: [MME] Microsoft Sound (Mapper) (preset)
Output: [MME] CABLE Input (VB Audio Virtual C. Note that this output setting is required to pipe demodulated signal to the decoder in the next section of this document.
Latency (ms): 100
Unity Gain: unticked, and
Filter Audio: unticked. (See Figure 6).

Foxtelam Decoder

To Decode the Fox-1 telemetry data, you will need the Foxtelam decoder program, currently version 1.04f.

1. Download the software and the User Guide from www.amsat.org/foxtelam-software-for-windows-mac-linux/.

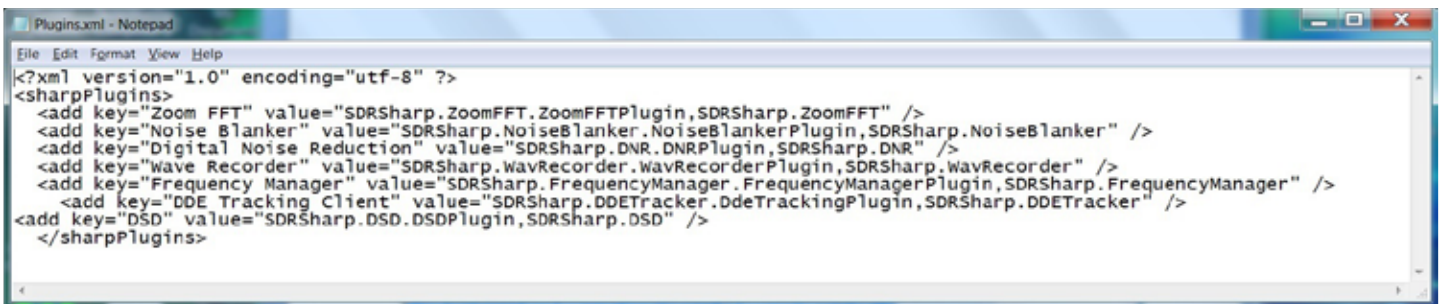


Figure 4.

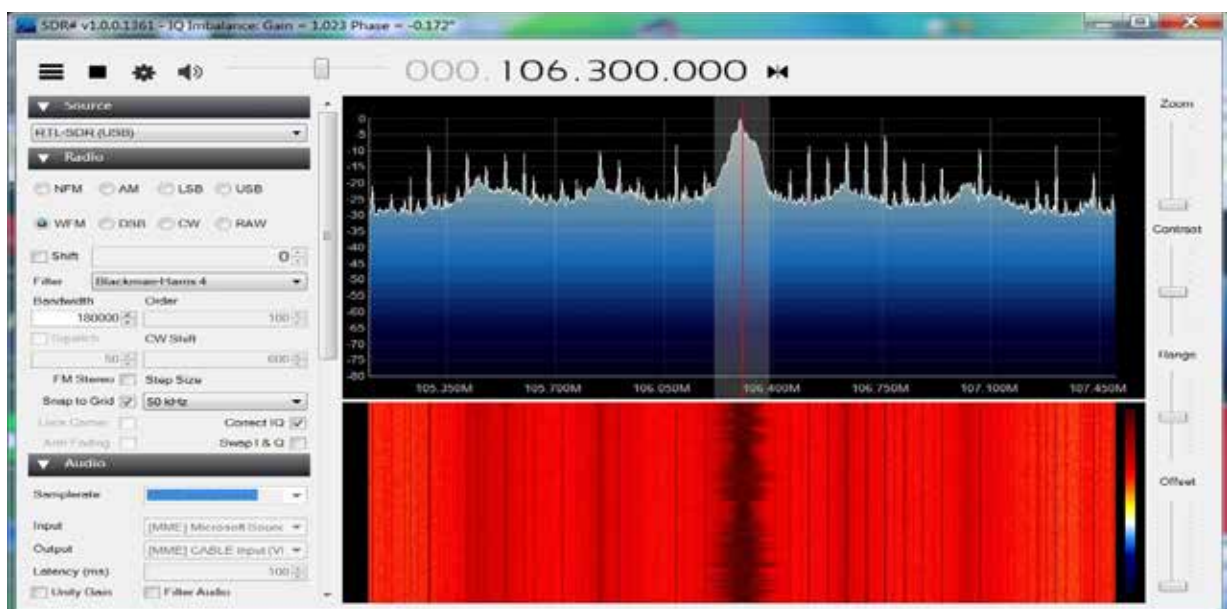


Figure 5.

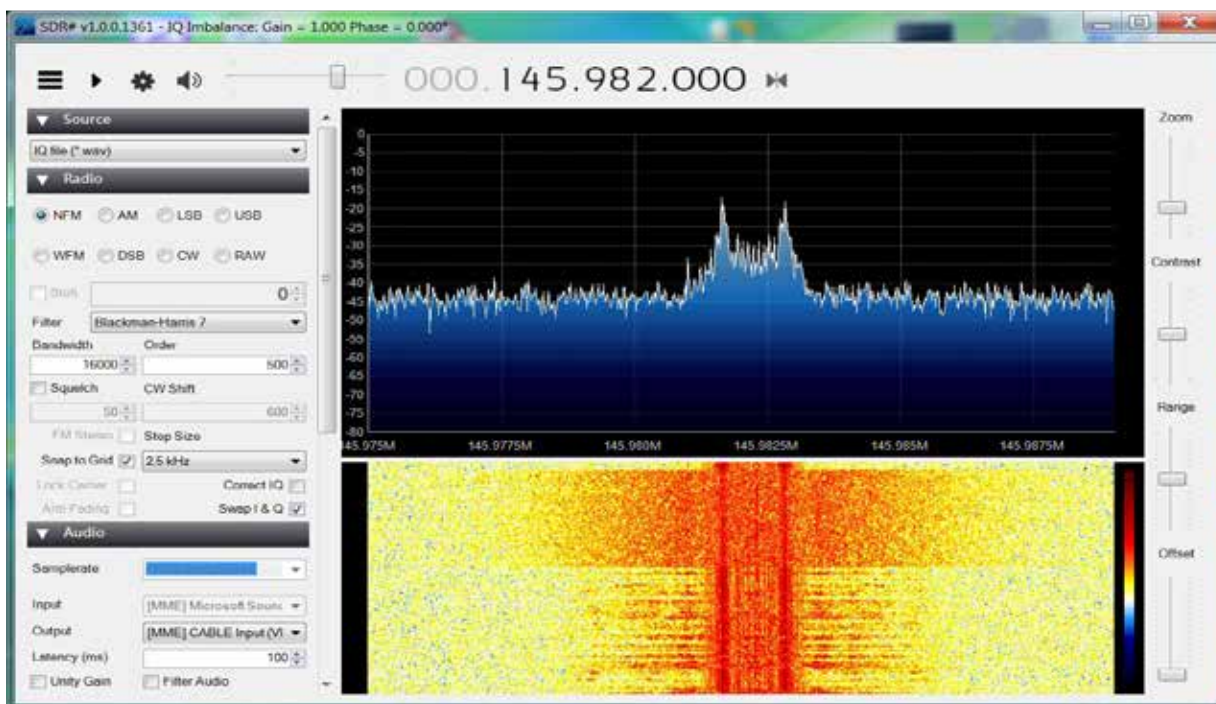


Figure 6.

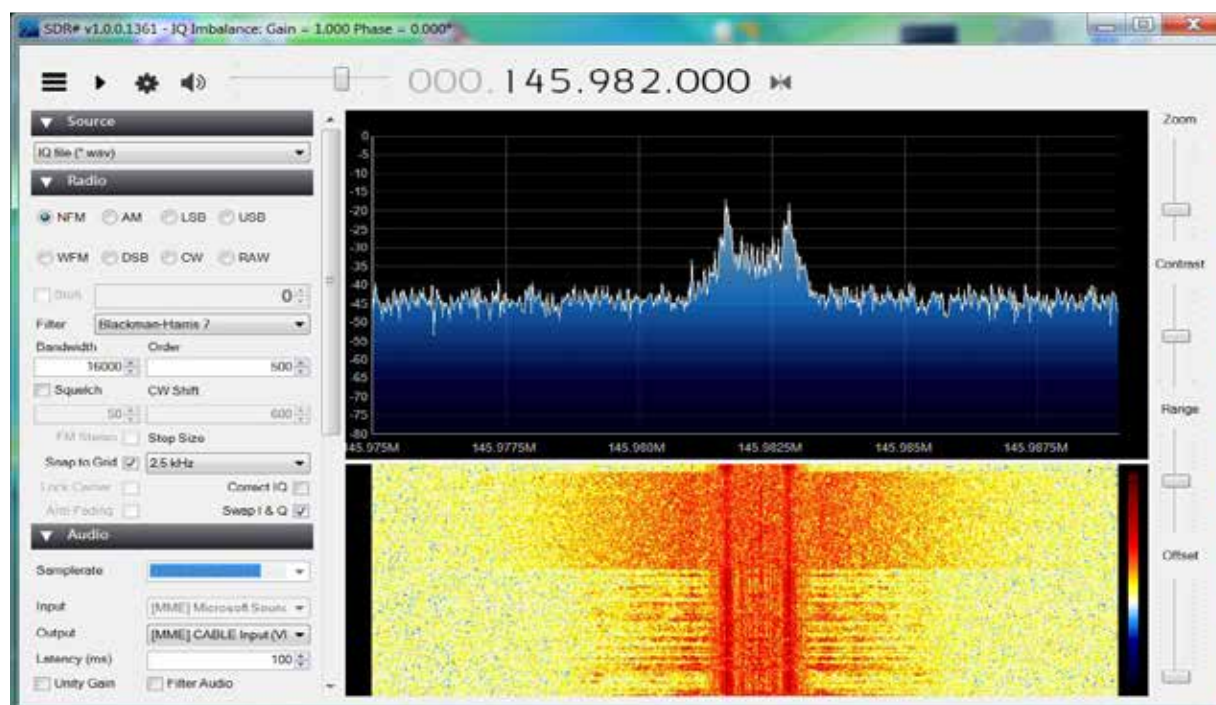


Figure 7.

2. Read the Manual you have just downloaded.
3. Unzip the software from 1 and install the program.
4. Run the program and download and install the latest version of the Java Runtime Environment (JRE), if required.
5. Download and install Microsoft Visual C++ redistributable, if required.
6. To test your system, download the wav files (Safe mode) from amsat.us/FoxTelem/recordings/. See section 3.3 of the manual. These files are for the HSDR program and give odd results with SDRSharp. Note that "Correct I Q" must be unticked and "Swap I & Q" must be ticked to give the correct frequency indication. Patrick, WD9EWK, also has a good source of test files from HSDR. (See dropbox.wd9ewk.net/ and Figure 7.)
7. Start Foxtel, which should default to the "Input" tab.
8. From the "Select Audio source and press start" drop down box, select "CABLE Output (VB-Audio Virtual," sampling rate "48000" (Default), "AF" and "Low Speed"). (See Figure 8.)
9. Start SDRSharp, and select the "Safe




Mode (RF) HDSDR wav file,” and run the file.

- From Foxtel, select “Start” and the data should appear on the two bottom windows (Figure 9).
- Select the AO-85 tab to display collected data to confirm that the system is working.
- Using the tracking program, find

a useful pass of AO-85 and start collecting data.

For more information on amateur radio satellites, see “2017-Edition Getting Started with Amateur Satellites,” by G. Gould Smith from AMSAT-NA (www.amsat.org/product/2017-edition-of-getting-started-with-amateur-satellites/). The forum at

amsat.org/meet-the-fox-project has lots of useful information on rtl-sdr dongles.

If you require any assistance with the software, you may contact the author at z12bac@amsat.org 

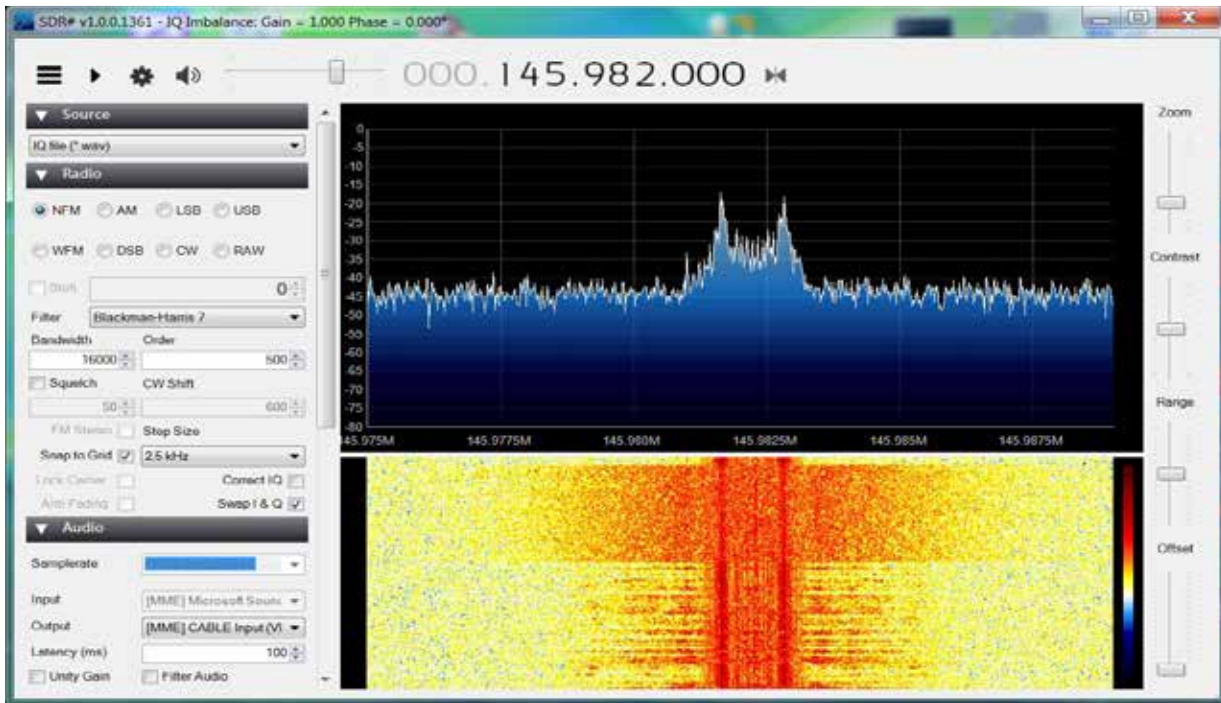


Figure 8.

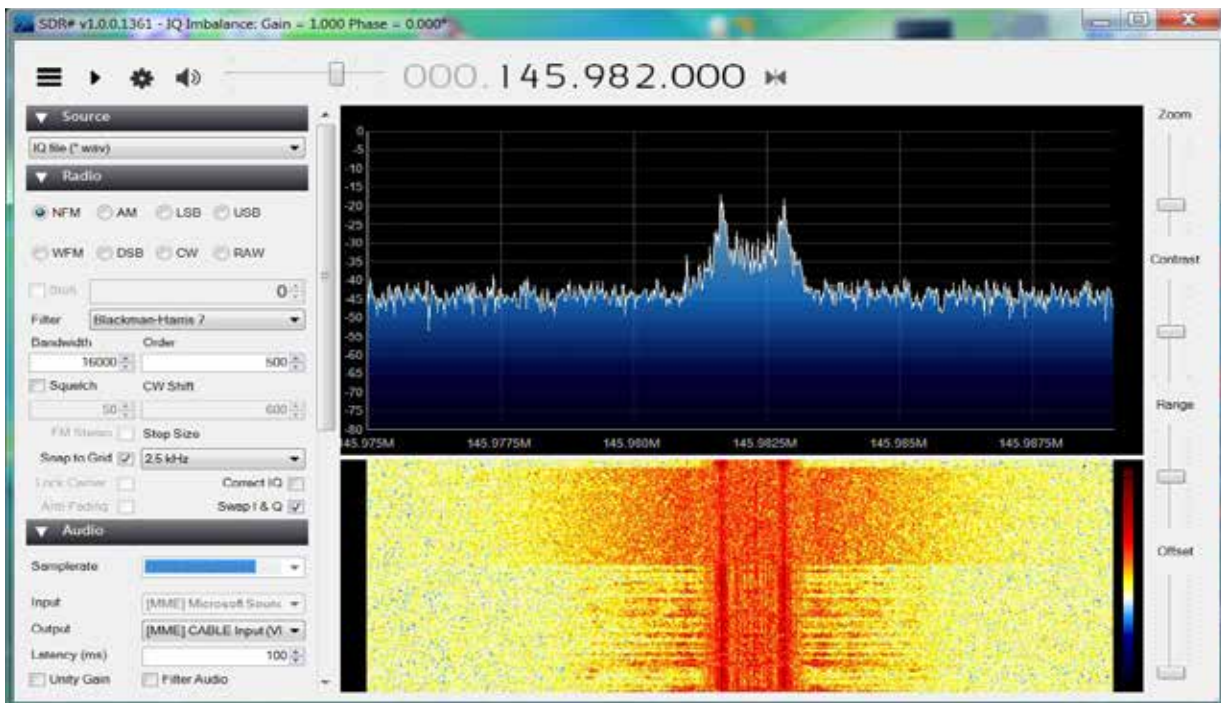


Figure 9.

RTL-SDR for Flying Objects Besides OSCARs

Scott Chapman, K4KDR

On any given day, a handful of radio transmitter-equipped amateur balloons float over the U.S. and even more fly around the world. But on Monday, August 21, 2017, that number ballooned (sorry) to around 148 according to Bob Bruninga, W4APR, to coincide with the total solar eclipse that traveled across the country from coast to coast. Using the popular APRS system to report their position (along with other data), these balloons created a dramatic visual on the HabHub Tracker site (tracker.habhub.org), as shown in Figure 1.

Receiving high-altitude balloon transmissions is yet another activity we can enjoy with an antenna pointing skyward. The amsat.org website lists almost 20 amateur satellites active for 2-way voice contacts plus several more with packet digipeaters. But, there are well over 1,000 satellites in Earth orbit! Add to that the high-altitude balloons aloft each day, and you can find many radio-carrying objects above the Earth to challenge your

ability to receive and decode.

Like so many aspects of Amateur Radio, receiving downlinked voice and data from objects in space can be as simple or complex as you want to make it. Similarly, you can participate on a small budget or spend big money. Of particular interest to me is that you can always learn something new. You'll simply never run out of ways to test your ability and increase your knowledge base.

So, let's talk specifics about what you can receive beyond our large array of OSCAR satellites and the ISS. In Low Earth Orbit ("LEO," up to 1,200 miles/2,000 km), weather satellites have passed above us for years. More recently, space has become increasingly crowded with much smaller CubeSats that transmit digital telemetry or recorded audio. Some even have cameras that can downlink images to amateur radio stations. The elite few that achieve OSCAR status have probably been used for 2-way voice QSOs by most amateur satellite operators. The relatively low altitude of these LEO objects allows many listeners to receive them with very modest equipment.

The larger commercial and military satellites that need to appear stationary above a single point on Earth are much higher in geosynchronous orbit (GEO) at around

23,000 miles (36,000 km). To receive signals from these satellites, you gain the advantage that they are stationary relative to your location. However, with the distance being so much more than the LEO satellites, at least a basic directional antenna will produce better results.

I particularly enjoy one other family of radio-equipped high flyers. This discussion started with a mention of amateur high-altitude balloons. But twice daily (1100 and 2300 UTC), the National Weather Service releases balloons equipped with weather data sensors, a GPS receiver, and a radio transmitter. For several hours, these balloons go where the upper air currents take them, constantly transmitting weather data plus telemetry which includes their latitude, longitude, and altitude. The addition of altitude data makes it particularly enjoyable to plot a weather balloon's track on Google Earth to follow along in real-time as I did when favorable winds carried a 2300 UTC balloon across Virginia well within reach of my 70 cm antenna (Figure 2).

Rumor has it that if you track one of these Weather Service "radiosondes" to its landing site, it is even possible to transition to fox-hunt mode. Who knows, as long as private property is respected and common sense

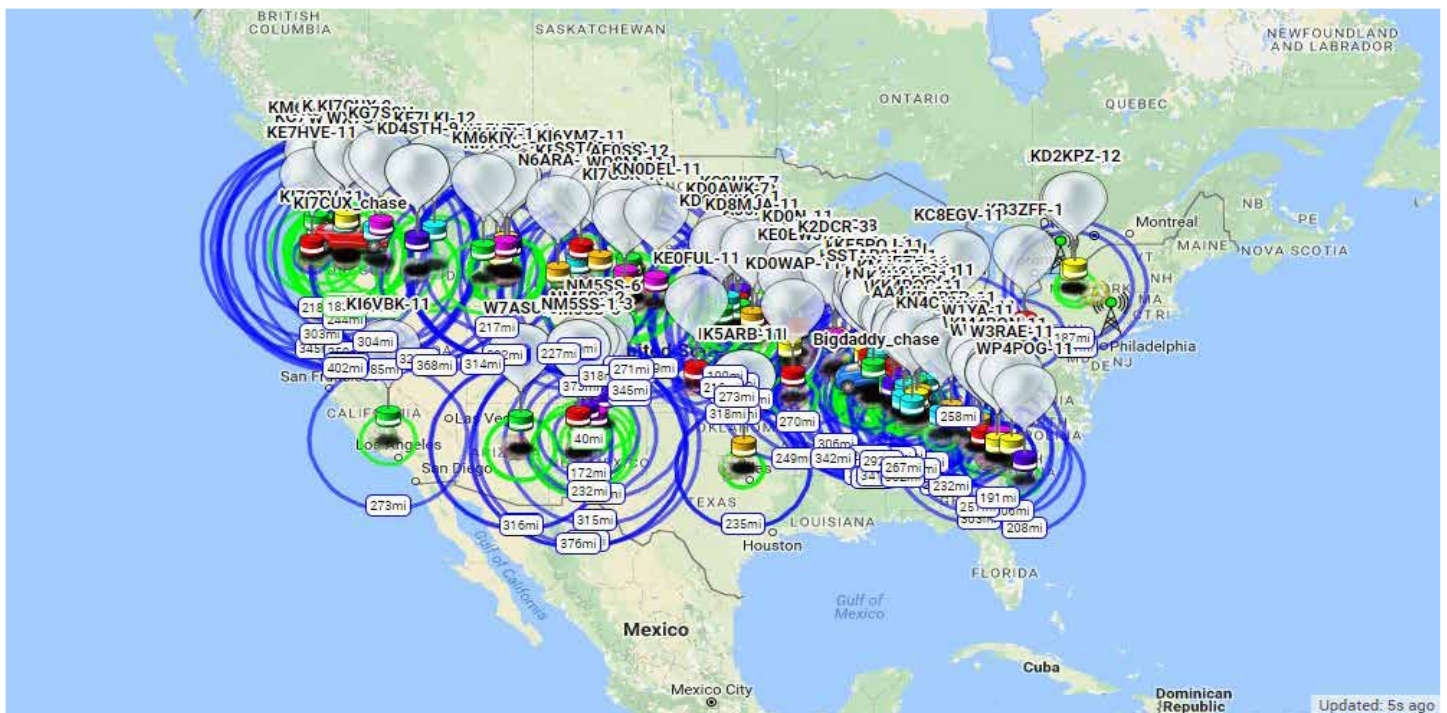


Figure 1 — Amateur High-Altitude Balloons concentrated along the path of totality during the total solar eclipse on Aug. 21, 2017.



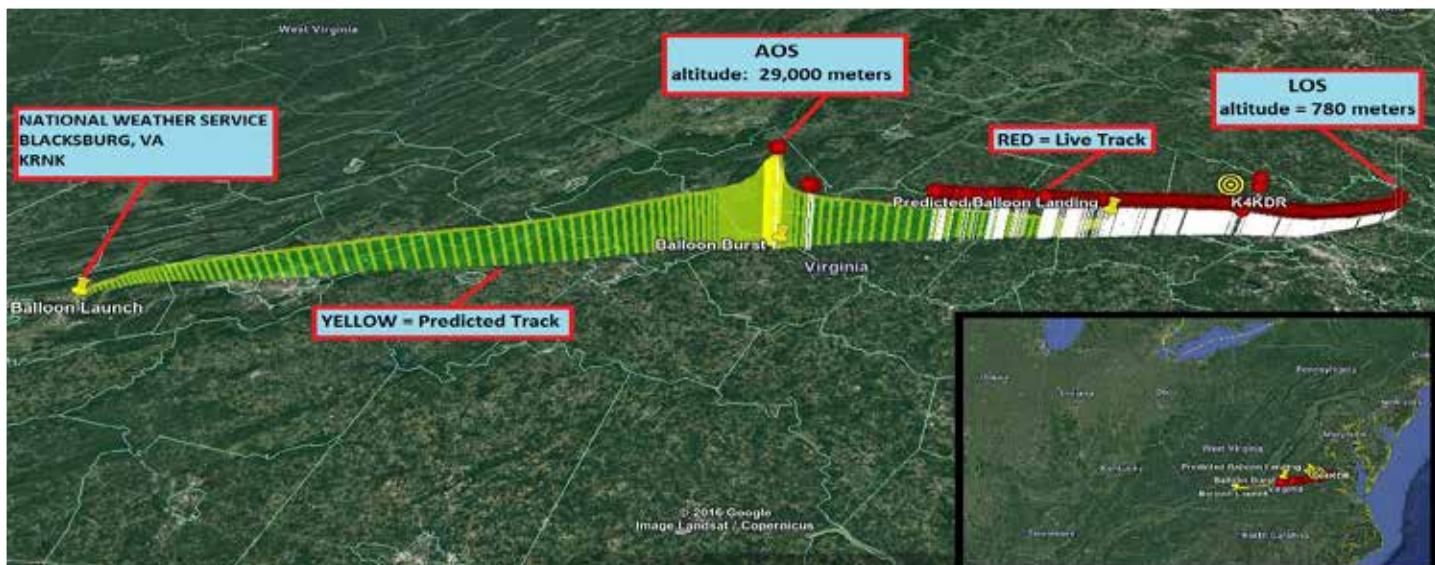


Figure 2 — Projected path of a NWS Weather Balloon Radiosonde on 404 MHz with live location telemetry (red dots) plotted in.

prevails, I have heard that someone could even recover one of these devices fresh from its journey to nearly 100,000 ft. (30,000 m) or higher (Figure 3).

So what kind of RF equipment do you need to receive all these signals from the upper atmosphere to LEO? With 2 m and 70 cm being the most common bands for LEO satellites, most operators probably have radios and antennas more than capable of doing the job. But keep in mind that for most of these objects, the goal is to get the received signal into your computer for processing. If you have a radio that is already setup to pipe received audio into your computer, then you

are already set to decode a portion of the signals we're talking about. But you might decide to go another route.

By now, most folks are familiar with Software Defined Radio (SDR). SDRs are most commonly configured as little boxes with an antenna connector and a USB jack. Using a nice transceiver to receive satellite telemetry is perfectly fine, but the focus of this article will be using an SDR for the RF portion of the job. By design, SDRs are ready made to pass what they receive to your computer.

A common first-step into the SDR world

is the basic \$20 RTL-SDR. See www.amazon.com/RTL-SDR-Blog-RTL2832U-Software-Defined/dp/B0129EBDS2.

If you enjoy what you can do with a basic SDR, then you will soon notice that others are enjoying increased performance and expanded frequency range with more advanced SDR products from Airspy, SDRPlay, and others. Some SDR devices even allow you to both transmit and receive. The ways to challenge yourself and learn with these devices is virtually unlimited.

But please don't let a comment like that scare you off! With a \$20 SDR, a simple

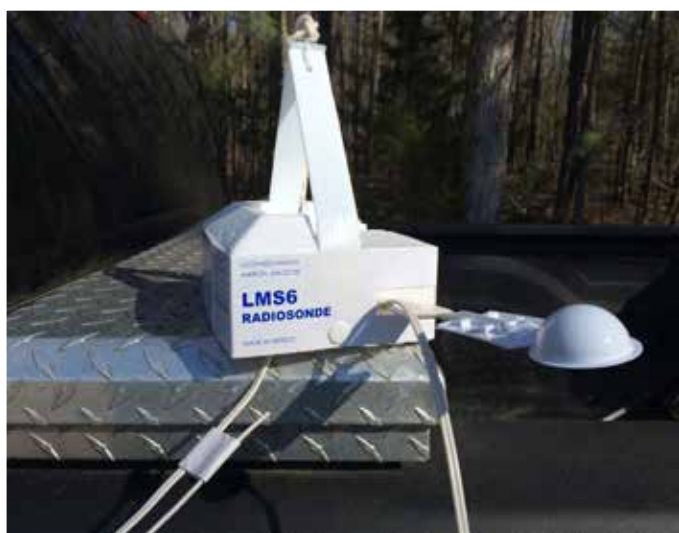


Figure 3 — New generation of National Weather Service Radiosonde, the Lockheed Martin LMS6. The Blacksburg, VA NWS office is one of the first to transition to the new 400 MHz units.



Figure 4 — L-band Helical Dish Feed made from #10 copper wire with PVC support (easily removable as dish is used with many different feeds).

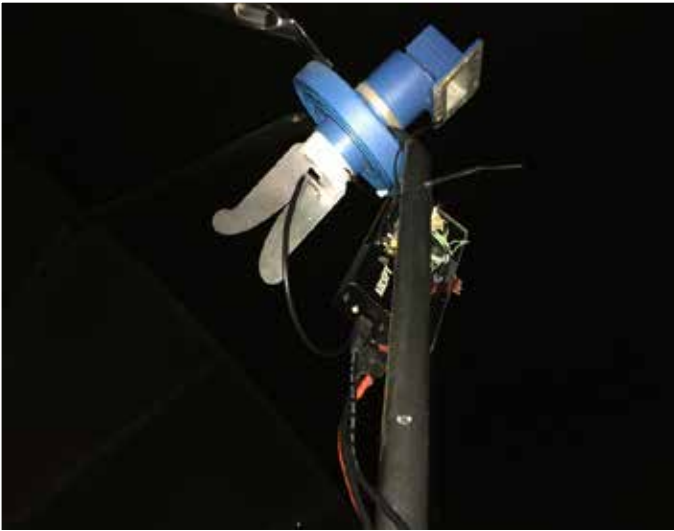


Figure 5 — RFSpace UWB-4 Vivaldi antenna used as a linear feed on a 1.8 meter dish for receiving GOES Weather Satellites.

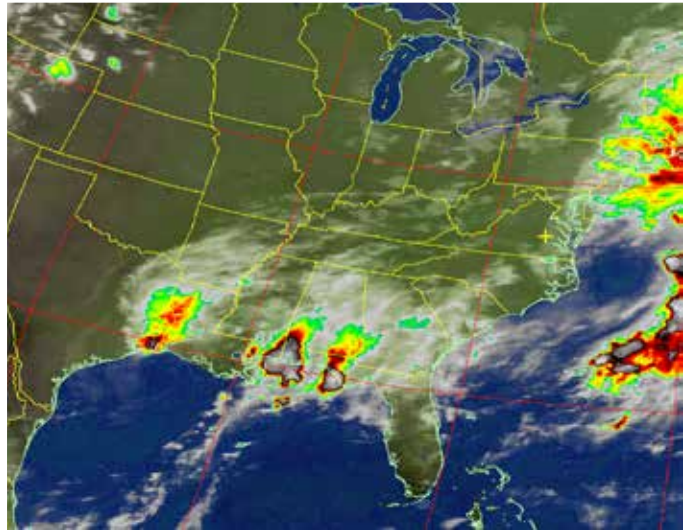


Figure 7 — NOAA-18 APT image from Aug. 30, 2017 as heavy rain from hurricane Harvey moves farther inland.

antenna, and some free software, you can receive wonderful weather satellite pictures, CW and digital telemetry beacons from CubeSats, APRS packet data from a wide array of devices, and the list goes on and on. This is most certainly an aspect of Amateur Radio where you can walk before you run. This is very much a learn-as-you-go part of our hobby.

We have talked about the radio (SDR) part of it, but what about an antenna? We're talking about objects that are up hundreds, or even thousands, of miles in the air, after all.

You can receive the most powerful satellites with an omnidirectional antenna. Many of us started learning about satellite telemetry reception by downloading weather imagery from the NOAA satellites on 137 MHz. As you already know from your OSCAR activities, antenna polarity is a consideration when communicating to and from space. So, as you research your antenna options online, you will come across references to omni antennas configured for circular polarization such as the QFH, crossed-dipole, and others. Calculators and scale plans are available, so it's cheap and easy to build your own. Seeing a color weather satellite picture appear on your screen downloaded with an antenna you built yourself is just plain fun.

To extend your range and to allow you to receive the lower-powered CubeSats, of course, the next step up is a directional antenna. I don't have to tell you how effective the Arrow or Elk hand-held antennas are



Figure 6 — RFSpace UWB-4 Vivaldi antenna used alone; PVC + a wire tie makes an excellent mount.

for satellite communications. They are an excellent place to start. While not being circularly polarized, they make up for some of that loss with the gain provided by their design.

As with the popular Arrow and Elk antennas, many reading this will also have larger, rotator-mounted antennas dedicated to

satellite communications. If they work well for voice communications, then, of course, they'll do a great job receiving telemetry or anything else transmitted from space.

I should mention that there are even more antenna styles to experiment with when receiving satellite downlinks than the familiar yagi designs mentioned above. While 2 m and 70 cm are popular for CubeSats, much of what you'll want to explore from GEO will be on L-band (1 to 2 GHz) and even higher frequencies. Polarity is still very important, so you will want to be sure to match your intended target.

For example, L-band LRIT weather satellite imagery from GOES-13 and GOES-15 uses linear polarization. If you are using a dish to receive these signals, your best result will come from a linear feed. Other satellites use circular polarization, so once you confirm, say, that you need Right-Hand-Circular-Polarization (RHCP), then buy or build your antenna accordingly. Don't forget that if you're using a dish, the polarity will be reversed when the signal bounces off the dish onto the feed! Figure 4 shows a helical feed built for a RHCP signal, but it's wound for Left-Hand-Circular-Polarization since the reflected signal off the dish gets reversed.

Another excellent linear antenna choice, especially when just starting out, is the Vivaldi by RFSpace. You can use these little miracle antennas alone or as the feed point on a dish. RFSpace has good products, or you can build your own (Figures 5 & 6).



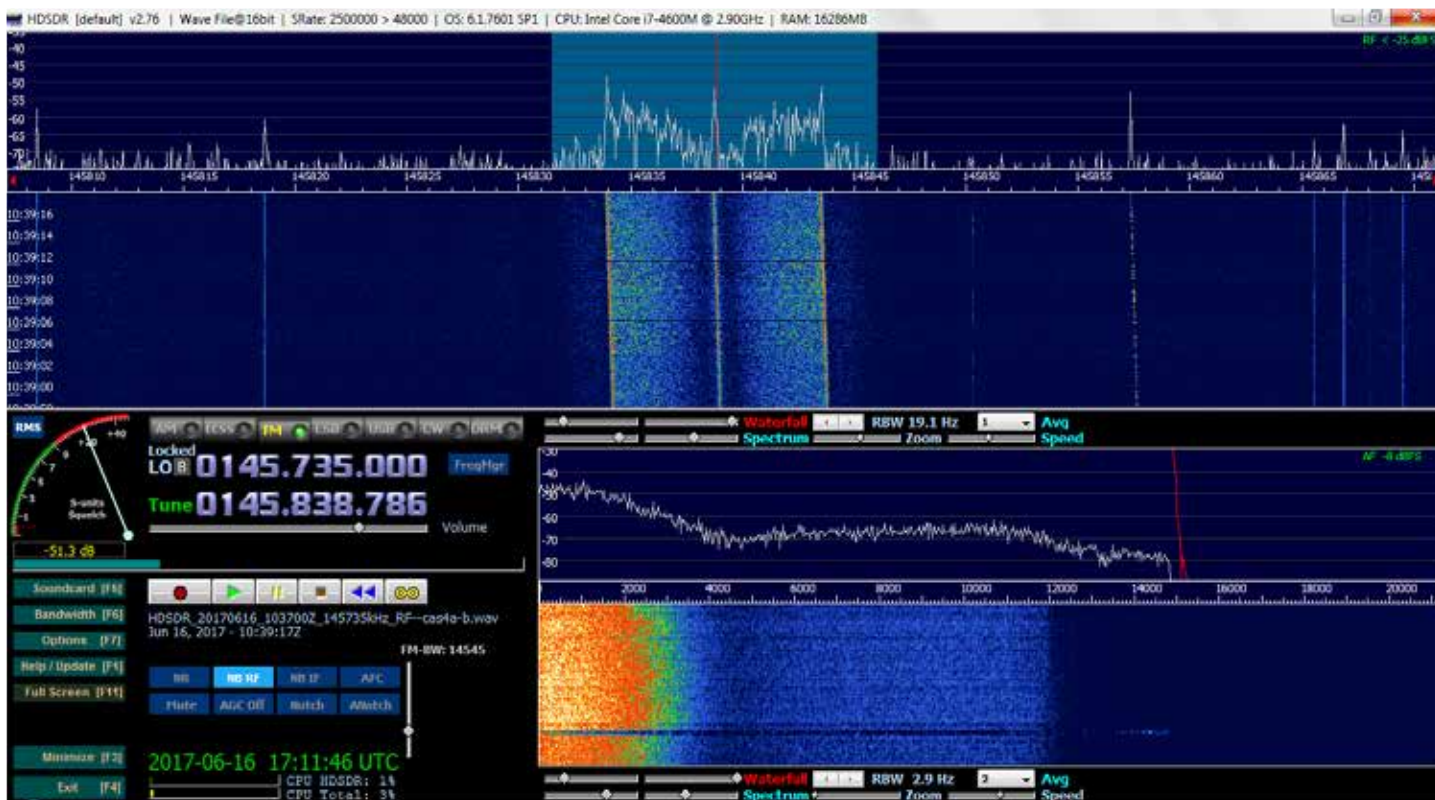


Figure 8 — HSDR software with a strong FM signal from the CAS-4A cubesat. The top window is the RF spectrum; in the bottom-right we see the output audio. Both RF and the audio are filtered & adjusted to provide the highest quality decoded data.

Now that we are receiving RF from amateur balloons, weather radiosondes, and satellites from all altitudes, how do we turn those signals into pictures, telemetry, digitized voice, or whatever? You know, the fun part!

There is no single answer to that. Radiosondes and satellites transmit on various frequencies using a variety of modulation types. The data is encoded using some different techniques, and we depend on documentation from each object's project team to help us with the correct settings and software.

But do not despair! To say there is a lot of help available online would be an understatement. You will be amazed by the amount of information from other hams on the internet to teach you how to get from a radio signal to all kinds of interesting data on your screen. For example, Jan van Gils, PE0SAT, has a wonderful website full of helpful info (www.pe0sat.vgnet.nl/decoding/block-diagram/). To start, see his overview of signal decoding. It does a much better job explaining how all the parts work together than anything I could write here.

What about all those satellites, frequencies, and modulation types? No problem! Mike

Rupprecht, DK3WN, has an incredibly rich website that you'll want to bookmark. A page that you will reference VERY often contains important information about all the active CubeSats (www.dk3wn.info/p/?page_id=29535). Also, Mike has written an endless list of utilities and decoders for the majority of orbiting CubeSats. On his site, you will see download links for all the software you need.

The exact software you need will depend on the satellite or radiosonde being received. I confess that a learning curve exists for all this, but with all the help available online, it's a fun journey to make. I went from absolute zero and first learned to decode NOAA Weather satellite imagery. It was difficult at first because I had to chase the signal across the screen as the satellite passed my location! Yep, I had no clue about Doppler shift. So, I learned about that plus the different modulation types from all the helpful folks online and just kept challenging myself from there (Figure 7).

Regardless of how you decode the data, the first thing you need on the computer is an application to talk to your SDR. Your research will turn up names like SDR# (SDR-Sharp), HSDR, SDRuno, and a

long list of others for use on Windows. Try as many as you wish and settle on the one that works best for you (Figure 8).

Those SDR applications, plus the majority of the decoding software from DK3WN, all run on Windows. While you can decode a LOT of satellite telemetry on a Windows computer, other transmissions require a Linux operating system. This has nothing to do with the satellite, but rather that the software written by skilled amateur programmers happens to run on Linux. Please don't let the thought of working with a different computer system prevent you from enjoying some of the more complex satellites! Once again, the internet is overflowing with Amateur Radio operators who can't wait to help. As for your computer, Linux will run great on that old laptop that you don't use anymore. Or, you can get double-duty out of your existing computer by booting it to a complete Linux system from a USB flash drive. Reboot without the USB drive, and you're right back to your Windows system, untouched and unchanged.

One software platform that you will hear more about on Linux is GNU Radio. GNU Radio is an amazing application that provides

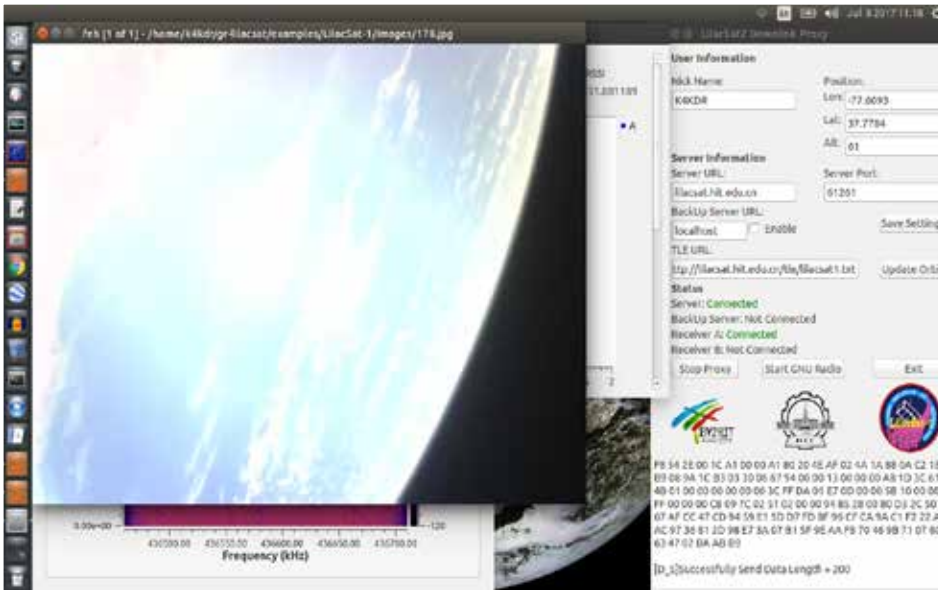


Figure 9 — Using GNU Radio flow graphs from Daniel EstÈvez (EA4GPZ), LilacSat-1 transmits a live picture from space on 70cm in response to a packet command transmitted on 2m FM.

us with a visual interface of interconnected blocks. These blocks work much like conventional electronic components; signals might arrive representing the RF that your SDR received and pass through filters and decoders just like the processing on a printed circuit board. In the end, you get audio or digital data in a format that is readable. Sound familiar? All we're talking about here is using a computer to do the same kinds of things that you have done for decades.

GNU Radio has made it possible for satellite project teams and savvy amateurs to create custom programming that allows us to do incredible things with these little satellites. A fellow ham that you will want to follow is Daniel EstÈvez, EA4GPZ, who uses his programming and math skills to create GNU Radio flow graphs that decode the newest and most complex space communication methods. For example, for the recent LilacSat-1 satellite, Daniel expanded on

the foundation provided by the LilacSat Project Team at the Harbin Institute of Technology in China to allow us to decode spacecraft telemetry, GPS location data, JPG pictures taken in space, PLUS the digital voice downlink from LilacSat-1's onboard FM repeater! His work is both incredible and all freely available. Many other satellite decoders and utilities are available from Daniel at github.com/daniestevez/gr-satellites (Figure 9).

What about those twice-daily weather balloon radiosondes? As more National Weather Service locations transition to 400 MHz units, the equipment that you already have is perfect to receive their signals. Here is another case of decoding software that runs on Linux. Much like SDR# and HDSDR in Windows, GQRX is a popular SDR application for Linux computers. The audio from GQRX flows into the LMS-6 radiosonde decoder, and the text output easily can be parsed into a common KML file for use in Google Earth. No fear, the work is already done; you don't have to learn how to program!

As the decoder loops every 15 seconds or so, you get a fascinating display on Google Earth as the weather balloon climbs well above the altitudes frequented by passenger aircraft. After bursting, the entire package descends by parachute and can cover

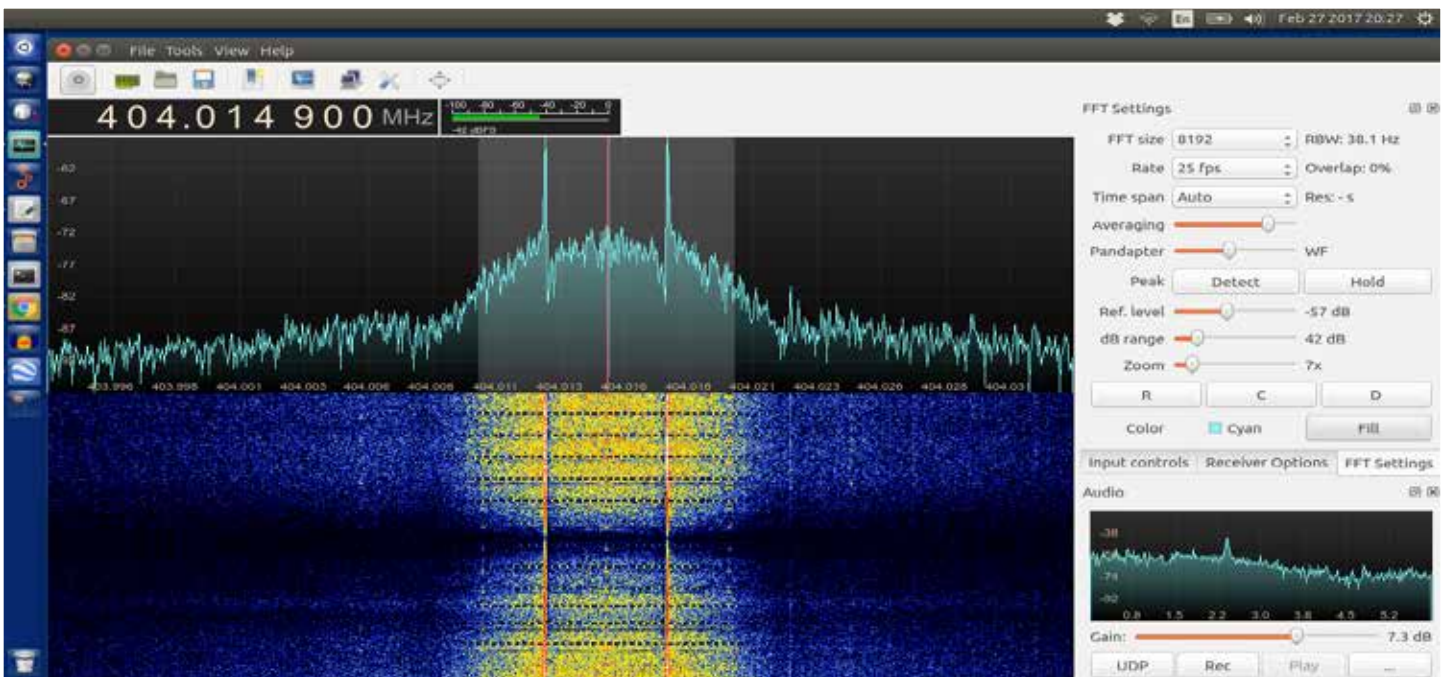


Figure 10 — A 400 MHz National Weather Service radiosonde transmitting from high altitude and received in GQRX on a Linux computer.



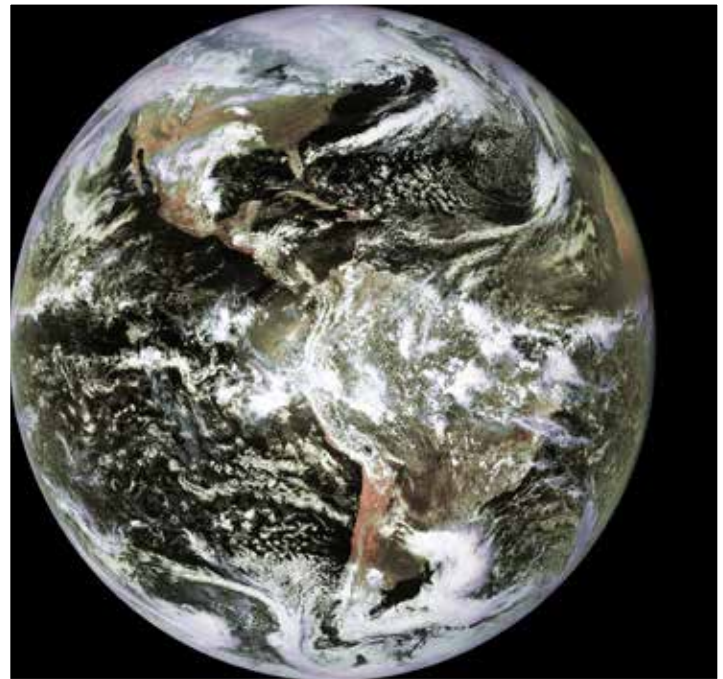
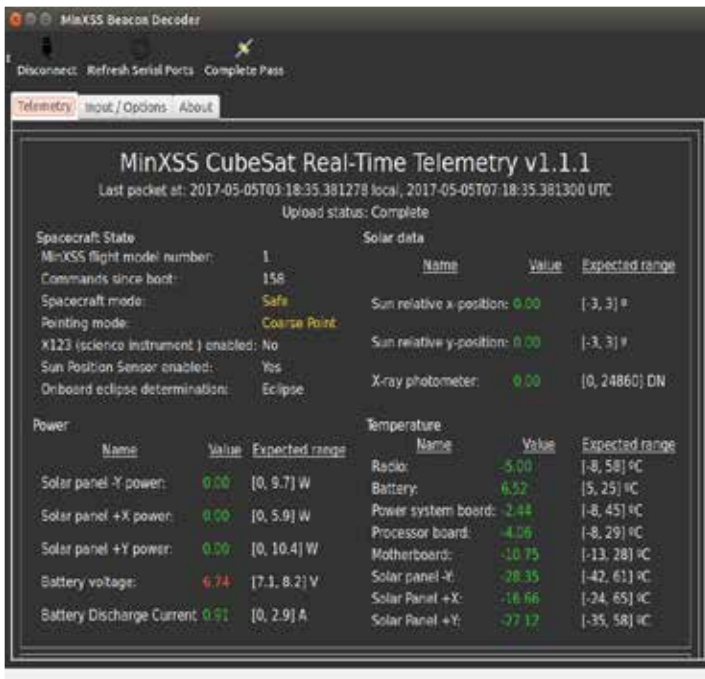


Figure 11 — Telemetry received from the University of Colorado at Boulder’s MinXSS cubesat & automatically forwarded to their central database.

Figure 12 — A full-disk image from GOES-13 in geosynchronous orbit using a 1.8m dish & Airtspy SDR, decoding software by Lucas Teske.

incredible distances before touching down. It’s great fun to track and see how far you can continue to receive data as the altitude gets lower and lower. And remember, you’re not pointing your antenna “blind.” The radiosonde is reporting its GPS location to you. So, you know exactly where to aim. Satellites are a wonderful challenge, but these weather balloon transmitters are a fun variation and allow you to enjoy something “different” (Figure 10).

Other than the fact that receiving and decoding a wide variety of signals from satellites and balloons is a great challenge and a lot of fun, what’s the big deal? Well, most of these little CubeSats are sent into orbit by universities and other educational organizations. Part of their project is often the creation of a “ground station” at the school where they can transmit commands to their satellites and receive downlink data when the satellite passes over their location. But that’s only a couple of times per day if they are lucky! Without help, these teams miss out on the vast majority of the data that could be obtained from their CubeSat. Fortunately, established collection sites allow you to upload the packets you receive so that they can be added to the telemetry database that these project teams will use to learn from their little experiment platforms

in space. To these students, it’s a VERY big deal (Figure 11).

If you enjoy learning new things and would like to do more than just talk via satellite, you will not regret experimenting with what you can do with an SDR, your antennas, and a computer. Lots of help is available online, and you will surprise yourself with what you can receive and do with that data. One day you are enjoying 137 MHz NOAA weather satellite pictures from an omnidirectional antenna and, before you know it, you have a dish pointing at a GOES satellite in GEO where you can download full-disk pictures of Earth (Figure 12). 🌐



eBay Sellers Donate to AMSAT

Are you an eBay seller? One item, ten items, or a full-time business you can donate a percentage of your winning bid to AMSAT.

To do so, do not list your item with the basic listing tool, select advanced tools. eBay will give you a warning message that it is for large volume sellers, however this is where the eBay for Charity tool is found.

You can “select another nonprofit you love” and search for either AMSAT or Radio Amateur Satellite Corporation. Choose the percentage amount of the sale you would like to donate to AMSAT, and boom!

When your item sells and the winning bidder pays, eBay will deduct the percentage from your take and forward it to AMSAT.

Sometimes we are getting rid of our old equipment, sometimes selling something new. In any case, please consider giving a piece of the pie to a new satellite and choose AMSAT for your eBay Charity.

Thermal and Noise Testing of the MVPS for ARISS

Ed Krome, K9EK

As most of you know, a group of AMSAT volunteers has been designing a new power supply to support continuing amateur radio communications from the International Space Station (ISS). The ARISS (Amateur Radio on the International Space Station) project, and the Space Shuttle program before that, has been connecting education groups right here on Earth with astronauts in space since 1983. ARISS now has completed over 1100 contacts.

The program is an excellent way to get young people interested in science, technology, engineering and mathematics and to spark a life-long interest. The world needs more technologists. ARISS is proud to help fulfill this need. Frank Bauer, KA3HDO, is the overall project manager, referred to by NASA as ISS Ham PI/PD. Lou McFadin, W5DID, is ARISS Chief Engineer. Kerry Banke, N6IZW, is the electrical designer and Bob Davis, KF4KSS, is the mechanical designer. This ARISS crew is spread from San Diego to Washington, DC, to Orlando. At least a dozen other individuals are involved with the Kenwood radios, software, frequency coordination and documenting NASA's myriad safety and design requirements.

Currently, the ISS carries two amateur radios, one from Kenwood and one from Ericsson. These radios are over 10 years old and getting a "bit long in the tooth." JVC Kenwood is donating a modified Kenwood TM-D710G FM transceivers to ARISS for use in both the Columbus (US) and Service (Russian) modules. The D710's are designed for earth-bound mobile use, so they run on 13.8 VDC at up to 13 amps.

Unfortunately, the ISS doesn't run 13.8 VDC power. The Columbus Module standard voltage is 120 VDC, while the Russian Service Module uses 28 VDC, thus requiring a new power supply. The new the MultiVoltage Power Supply, or MVPS, consists of a single "black box" (Figure 1). The MVPS is designed so that it can be plugged in anywhere on the ISS to provide the appropriate output voltages.

This does not sound too difficult. However, the supply also must run the HamTV

experiment (28 VDC @ 4A, continuous), 4 USB ports @2.3A each and 6 VDC 1.2 A supply — all with overvoltage protection, current limits, EMC filtering, pass-through capability and no switches for the different modes other than on-off. All voltages are available on each output connector; the specific interconnect cable only has the correct pins wired.

Internally, the basic conversion devices are five DC-DC converter modules (Figure 2). Two in parallel are 120 VDC in/28 VDC out at up to 7 A. Another is 28 VDC in/13.8 VDC out at 14 A, along with a USB converter and a small 28VDC in/6 VDC out module. All of the previously noted conditioning, limiting and protection devices are on separate circuit boards. That's a lot of stuff in that box! All the electronics were designed by and the prototype built by Kerry Banke, N6IZW. The physical containment and all mechanical drawings were created by Bob Davis, KF4KSS. A fully operating prototype of the entire MVPS was extensively tested by NASA

at Johnson Space Center earlier this year and passed with flying colors, an incredible accomplishment.

Space, even inside the ISS, is a much different environment from Earth. For one thing, heat moves in different ways. While conduction and radiation work the same, convection, a common heat transfer mechanism, doesn't. On Earth, when a heatsink gets hot, it heats the air around it; hot air becomes lighter and rises against gravity, taking the heat with it and drawing cooler air in behind it. In space, without gravity, the hot air cannot rise against anything. So, convection-type heatsink cooling must be by forced by fans.

All of these converters and associated electronics in the MVPS represent the latest and most efficient technology but still generate heat. These DC-DC converters are spec'd at ~85% efficiency. That means if every converter module were running at full rating (an unlikely but possible occurrence), they would generate approximately 80 W of heat. Somehow, the heat must be dissipated.

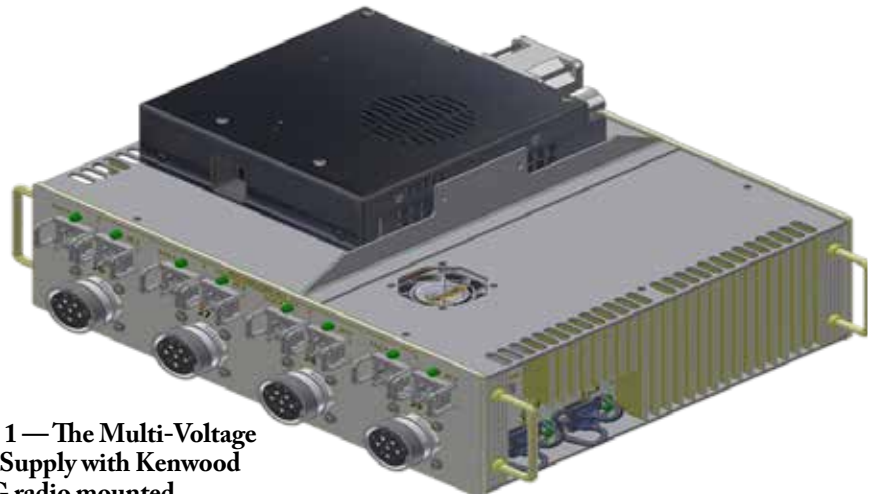


Figure 1 — The Multi-Voltage Power Supply with Kenwood D710G radio mounted.

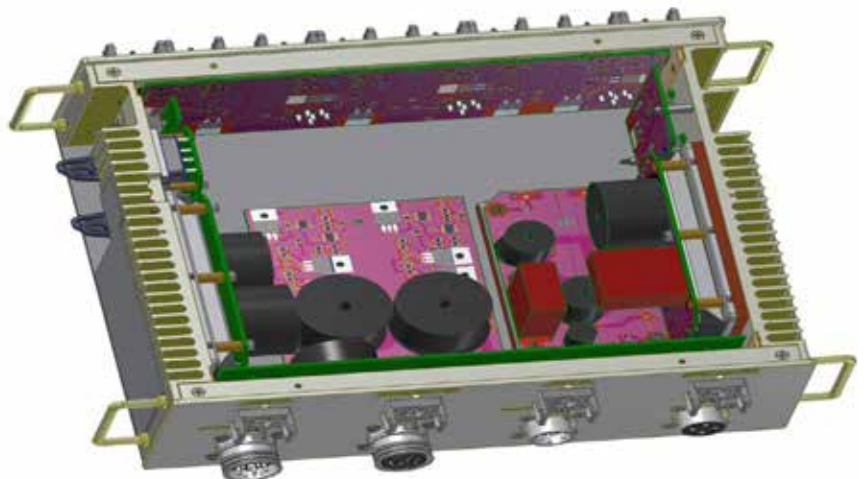


Figure 2 — Interior of MVPS model showing DC-DC converters and power conditioning boards



Also, human safety considerations require stringent criteria for skin temperature and noise. NASA requires that external surface temperatures not exceed 45 degrees C. for incidental contact. This requirement applies to MVPS, which has no “controls” other than a few switches. But things get hotter in space, so we use a 41 deg C limit.

Earlier this year, Lou McFadin asked me if I had any interest in joining the project. He thought that a mechanical engineer with a ton of practical and theoretical experience (although none of it in satellites or satellite technology) and 50 years of building and experimenting with electronics might be a useful addition. I had no idea how I might contribute, but it sure sounded interesting. And, after many years of both doing and managing a wide range of industrial machinery design projects and test labs, I thought I might be useful. My experience and the current projects may be of widely different disciplines, but the scientific method and a solid analytical approach work everywhere. And we learn as things evolve.

At the time I joined, the electrical design was mostly complete, and the mechanical design was proceeding. However, the cooling design had not been finalized, so I took on that part. I researched the subject and conducted various mathematical analyses, complicated by the presence of a large copper heat transfer bracket inside the case. I made some informed guesses but had no way to verify or disprove the results. Well, the best way to solve a problem like this is to test it.

So, McFadin sent me a blank case, and Davis sent me his design drawings. I have a milling machine in my garage, so I machined a case to Bob’s specs. To simulate the heat generation properties of the DC-DC converters, I made aluminum plates of the same footprint and mounted large lug-mount resistors on the plates. Values were selected so that 100 VAC on all 4 blocks in parallel would generate 80 W of heat. I bought a bunch of cheap digital thermometers and, after verifying that all would read within a few tenths of a degree F., mounted them around the case in areas where it was possible to have physical contact, as well as on the internal heat-generating blocks.

I mounted small, 40x40x28 mm, 18.5 CFM cooling fans directly to the cover of the case. I used two fans in series, not for more cooling capacity, but for redundancy. This machine has to last at least 10 years, so if one fan fails, we want to make sure the operation will continue without incident. In the final construction, the fans will each have their own separate variable speed controller. But at that stage, Banke was still working on the controllers. So, I ran many tests with a fixed amount of watts and fixed fan speeds and manually recorded temperatures after a few hours of stabilization. I also ran the same tests with one of the two fans disabled. To simulate possible failure modes, runs were made with the disabled fan freewheeling and also with the disabled fan mechanically stalled.

Given the importance of knowing how much

safety factor you have, we also ran tests at 100 W heat load. This gave us a good idea of how much air flow would be required to cool the MVPS under foreseeable conditions. The net result of this early testing was that the original fans had more capacity than required. This result becomes significant because of noise generated. Higher CFM means higher fan speeds in a given envelope, and these 18 CFM fans could get rather noisy. We switched to 13 CFM fans of the same size; while quieter, they are not wonderful. Additional testing proved the smaller fans able to handle the heat load in all cases.

Manually recording temperature readings became rather tedious, so I automated the process. I pressed into service an old LabJack U12 A-to-D converter and data recorder with an old XP laptop. The cheap thermometers don’t have a data output, so alternate sensors were required. The junk box had some type K thermocouples and several Adafruit AD8495 cold junction/amplifiers that condition the millivolt thermocouple signal and give an analog read out in degrees C. Thermocouples are not particularly accurate but are adequate if properly calibrated. My experience with industrial machinery and test labs has shown that it is always a good idea to have more than one method of data acquisition. That way there is less of a chance of fooling yourself by making the same mistake more than once! So I built other sensors from TPM36 silicon temperature sensors; 3-lead devices in TO-92 packages that read out directly in degrees C. Thermocouples and TMP36’s were all calibrated together. These were referenced to two good quality (Omega and Tegam) temperature measuring devices and an ice bath. Eventually, all units were calibrated within +/- .2 degrees C. I changed all gauging and recording to degrees C because of the confusion of readings in both Fahrenheit and Celsius.

I epoxied two thermocouples into reliefs milled in the top of each heatsink inside the case. These would be the highest temperature points. A TMP36 was attached to the fins of each heatsink in locations where it would be possible for an astronaut to touch the power supply at the hottest part. After some experimentation, all four sensors were attached to the LabJack inputs as differential pairs. The LJ has eight single-ended analog channels, but using them all lead to noisy data. When attached as differential pairs, you only have four channels to work with, but you have much more control over the signal levels and resolution, and I had four sensors.

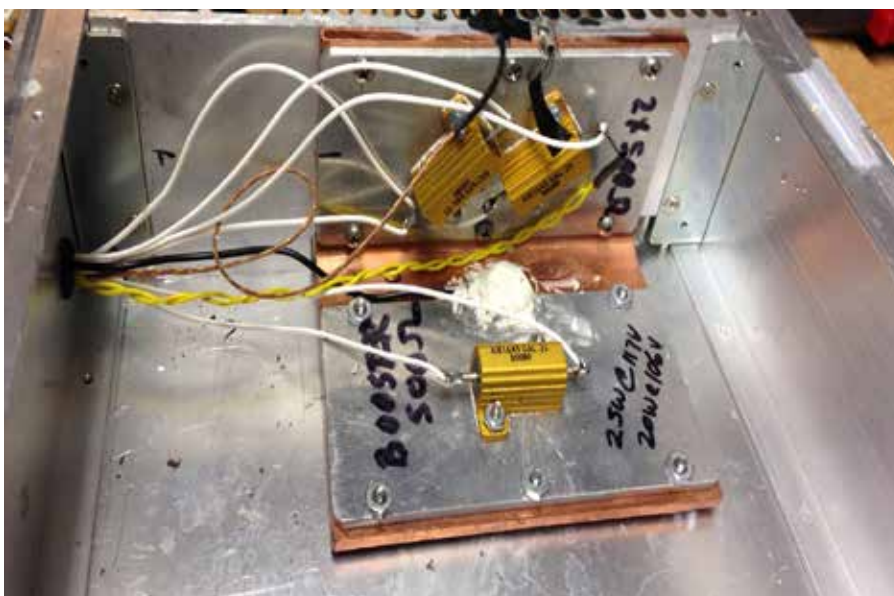


Figure 3 — Heat generation pallets simulating 120-28 VDC converters and copper heat transfer bracket.

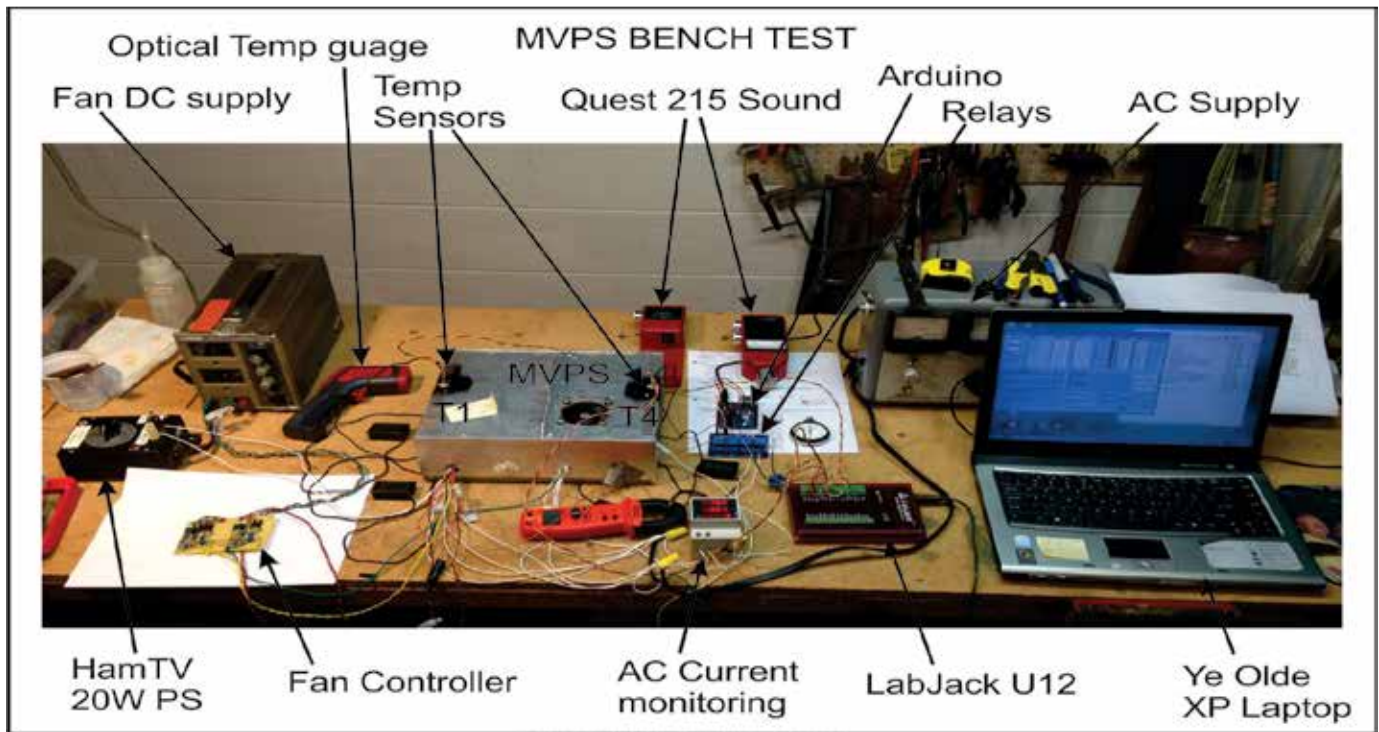


Figure 4 — Final, fully automated thermal testing setup.

Now, I could set a fan speed and load, start the LabJack and walk away. This worked well. By then, Banke had finished the fan controllers. While each controller has its own heatsink mounted thermistor and controls a single fan, there is a crossover between the controllers, so both follow the higher of the two sensed temperatures. The fans are set to a minimum speed for up to 29 degrees C (85 degrees F) and full speed at 41 degrees C (105 degrees F). Test series were rerun with the controllers with fixed loads of 66 W, 80 W and 100 W.

Having automatic temperature control and automatic temperature logging was great. However, all testing had been done with a constant load. The real world of ham radio operation is cyclic. JVC Kenwood has defined load profiles for three standard modes of operation. Voice mode is 25 W out with 60 seconds on and 90 seconds off. Digipeater mode is 2 seconds on, 2 seconds off. Repeater mode is 5 W, 20 seconds on, 1 second off, 20 seconds on, 50 seconds off. All were repeated continuously. So, a real test would have to be under the real load profile. This required yet another new trick. Also, the power supply must supply a continuous 28 VDC at 4 amps for the HamTV apparatus.

The popular Arduino microcontroller is designed to control external loads. All I had to do was learn how to do it. Arduino is programmed in C, and I'm not a programmer. But the tutorials also include many example

programs that do all kinds of interesting things. By connecting a relay board and using nothing more than modifications of the simplest demo program, an LED flasher called "Blink," I was able to train Arduino to turn a relay on and off in accordance with the prescribed load profiles. The relay was used to turn the AC heat generating source on and off.

Now the entire system was automated and could accurately duplicate the predicted load profiles and record data automatically. It wasn't very pretty, but it worked well.

Test sequences were run several times at each load profile. A typical data plot is shown

below. The effect of the power on/power off sequence is clearly visible, especially on the T4 curves. Interestingly, it appears that the rate of heating is roughly equal to the rate of cooling although the periods are different. This is because temperature rise during the "on" cycle occurs at a faster rate than the fan's ability to overcome the thermal inertia of the system. So, the system heats up. Eventually, the Delta-T (difference between ambient and heated mass) becomes large enough to increase the rate of heat transfer on the cooling cycle and stabilize the system.

The curves are raw data with no smoothing, integration or other manipulation beyond scaling and offset due to sensor characteristics

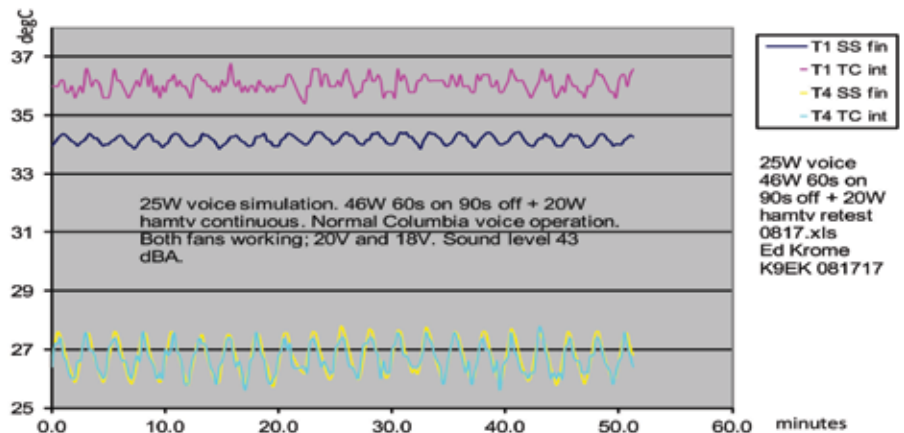


Figure 5 — 25 W voice mode simulation temperature curves.





Figure 6 — First experimental noise-reducing airbox.



Figure 7 — Second experimental noise-reducing airbox.

and calibration. No attempt was made to filter out noise. Since the LabJack takes data “snapshots” at timed intervals, sometimes the noise clouds the data, which explains the apparently erratic nature of some of the traces. But the trends are accurate.

Additionally, temperature readings were corroborated with both independent probe-type thermometers inserted in the fins and use of an optical temperature sensor. Since inexpensive optical thermometers are inaccurate on shiny surfaces, I applied flat

black paint blotches on the case to improve their accuracy.

Note that the “T1 TC int” (location T1, thermocouple, internal) is the highest temperature, but since it is internal, is not

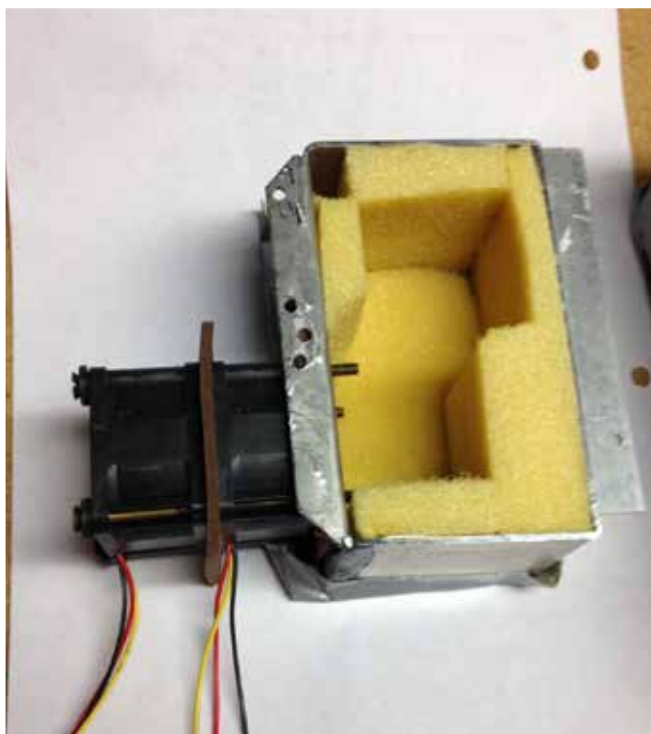


Figure 8 — Experimental airbox lined with SoundCoat Polymide sound absorbing foam.

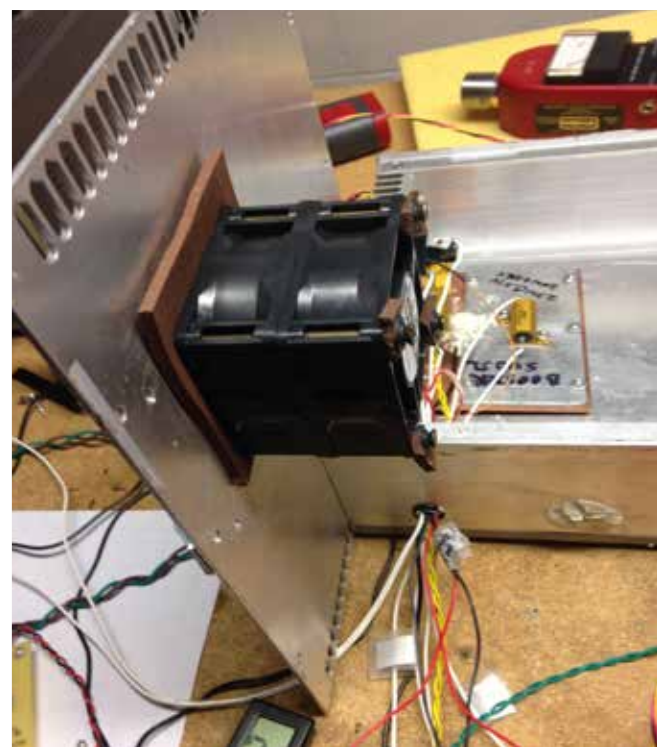


Figure 9 — Final fan stack attached to the case cover. To the right of the fans is one of the heat-generating pallets. To the upper right is the Quest 215 sound level meter.

a point of incidental contact for the crew. Therefore, the determining temperatures are from “T1 SS fin” (location T1, SolidState TMP36 sensor, mounted in the heatsink fins) and “T4 SS fin” on the other heatsink.

Then another quirk reared its head. The Kenwood TM-D710 used in the Service Module can be run at 50 W in voice mode, twice that in the Columbus Module. So, I ran a test sequence for the voice profile at 50 W. Then I ran the same test with one fan disabled. Maximum temperatures remained within specifications.


The bottom line is that, in this simulation, the fans and cooling system are adequate for any and all predicted operation, as well as considerable overload situations. With every test sequence, I had been taking noise level readings in dBA using a borrowed Quest 215 sound level meter. Early tests had indicated that the two fans, mounted directly to the case cover, were marginal to NASA requirements. With the logic that a longer, baffled path would reduce the sound level, the first experiment was to build an airbox, 3x3x2”, with the fans bolted to the side of the box, and the 3x3 side of the box bolted to the top cover. I tried various baffling and sound absorbing schemes, but none made significant improvement in sound level. I asked Bob Davis if he could give me more internal real estate. It’s crowded inside, so he could only give me 4x2.5x2”. I built and tested a new airbox, but noted little difference.

I contacted SoundCoat Co., specialists in sound level reduction. With our limited space inside the airbox, the SoundCoat engineers didn’t see the potential for much improvement, but they did send me sample NASA-approved sound reducing foam. Lining the inside of the latest airbox provided a sound level reduction of only 1-2 dB.

This required a reevaluation of the cooling system. Since 13 CFM had proven to provide adequate cooling, I looked at other types of fans to find lower noise levels. The next iteration was to use larger 60x60x25mm fans, which are specified at 15 CFM at 23 dBA noise level, over 10 dBA lower than the original fans. These were bolted directly to the top cover. And they worked just fine. The maximum sound level was measured at 43 dBA. NASA also requires analysis of continuous sound levels by sound power within octave ranges. Fortunately, the Quest meter is capable of octave measurements. All were satisfactory.

During the various stages of testing, I used an iPhone app to record the vibration spectrum. I found that I could estimate fan RPM from the peaks. While not immediately useful at the time, it proved valuable in later testing to show why one fan was considerably noisier than the other.

From observation of the voice profile temperature curves, it is apparent that one quirk remains; the T1 side runs 8 to 10 degrees C hotter than T4. The positioning of the fans and the internal configuration allows more cooling air on the T4 side of the case than on the T1 side, complicated by the fact that the T1 side generates slightly more heat. Since the fan speed controllers run both fans from the highest measured temperature, more even air distribution will result in lower fan speeds and quieter operation. While this can be fixed with baffles, that step will have to wait until all real components are inside the case.

This appears to be as far as the power supply testing can go right now. Temperature rise and noise level are satisfactory in the present configuration. The next step is to go through this all again — after all the real internal components, boards, DC-DC converters, connectors, wires, and who knows what else are together and operating. 

New Sat: FalconSAT-3

The Air Force Academy satellite FalconSAT-3 is now open for amateur radio use as a digital store-and-forward system. FalconSAT-3 was built in 2005 and 2006 by cadets and faculty in the Space Systems Research Center at the US Air Force Academy in Colorado Springs, CO, and launched in 2007 on an Atlas V. After serving in scientific and training roles, the Academy has now made the satellite available for Amateur radio use.

The satellite is in a 35.4 degree inclination orbit, with an approximate altitude of 465 to 476 km. The Packet Bulletin Board System is operating at 9600 baud with a 145.840 uplink, and 435.103 downlink. Output power is 1 watt, and the downlink is continuously on. Digi-peating is enabled for live QSOs, but unattended digi-peating operations is not authorized at this time. Current Keplerian elements can be found in the AMSAT distributed Keplerian elements.

More information can be found at www.amsat.org/falconsat-3/, and further

2017 ARRL New England Division Convention

Paul Graveline, K1YUB
Asst. Editor AMSAT Journal

AMSAT successfully educated, delighted and demonstrated satellite operation to attendees at the ARRL New England Division Convention held in Boxborough, MA, the weekend of September 9-10, 2017. AMSAT’s two forum presentations updated attendees on the organization’s current operations, activities and plans for the future. AMSAT Secretary, Paul Stoetzer, N8HM, presented the keynote speech at the Grand Banquet on Saturday. And Robert Hayes, KB1SWZ, conducted a live demonstration of working ham satellites in the outdoor flea market area both days.

AMSAT Update

AMSAT President Barry Baines, WD4ASW, kicked off the Saturday forum with an overview of upcoming launches, including Fox-1Cliff. He also described the strategic planning process currently underway to establish a multi-year vision and strategic plan for AMSAT. Additionally, Barry discussed the IT revolution and its impact on AMSAT’s website, membership database and online store operation.

Barry shared that the *AMSAT Journal*’s current primary need is developing a pool of relevant and interesting articles. Barry concluded by encouraging present members to help by recruiting new members and promoting the AMSAT Symposium in Reno.

Following Barry, Burns Fisher, W2BFJ, provided an engineering update. He discussed the Fox program, noting the close cooperation between AMSAT and Vanderbilt University. Burns reviewed next year’s proposed launch schedule, cautioning that AMSAT’s launch dates depend on the launching organization. Burns also stressed the importance of AMSAT’s ongoing collaboration with schools and universities to enhance the chances of securing a launch vehicle and date.

Looking ahead, Burns introduced a new satellite development initiative, “GOLF” (Greater Orbit Larger Footprint). Ideally, the initiative would orbit a series of satellites following the Fox series next year. Burns explained that AMSAT is looking further





At AMSAT booth (L to R), Ernie Bauer, N1AEW, Phil Smith, W1EME, Barry Baines, WD4ASW, Burn Fisher, W2BFJ.

into the future through the work of the ASCENT team, AMSAT Engineering's version of a "skunk works." A lunar orbiting satellite is one possibility.

Burns responded to the frequently asked question, "Why does it take so long to build and launch a satellite?" According to Burns, one reason is that testing is rigorous both physically and electronically. In fact, the potential satellites are mechanically tested not far from where the convention was being held. He noted that AMSAT has produced a number of YouTube videos depicting the process.

BUILDING AND OPERATING A PORTABLE SATELLITE STATION


Presented by Fred Kemmerer, AB1OC, and Anita Kemmerer, AB1QB

Fred Kemmerer, AB1OC, and his wife, Anita, AB1QB, have been responsible for the complete transformation of the Nashua New Hampshire Radio Club as well possessing a very impressive ham station and antenna farm. A few years ago, Fred decided he wanted to build a portable satellite station for Field Day. Early on, he realized that this would be an operating challenge in a rapid exchange environment like FD. The solution was to establish a three-person team to make the contacts. The team included a radio operator, an antenna operator and a logger. This seemed to work well and allowed more people to participate.

Over the next few years, he added more sophistication such as cross-polarized Yagis and computerized controlled tracking. The station expanded significantly so that it now requires at least one additional "helper" to make it all work!

GETTING STARTED IN AMATEUR SATELLITES

At the Sunday forum, Ernie Bauer, N1AEW, and Paul Stoetzer, N8HM, presented a session on getting started with amateur satellites. Ernie led for the first half, covering the fundamentals such as the different types of birds (LEOs, etc.), bands and modes employed by hams, FM, analog and digital type operations. He described the minimal equipment required, referring attendees to the AMSAT online store for antennas and tracking software.

Following Ernie, Paul invited the attendees to venture into the flea market where he and Robert Hayes, KB1SWZ, conducted a impressive live demonstration, making about 10 contacts during a fairly long pass. 



Satellite demos in the flea market area.



Sunday forum attendees watch Paul Stoetzer, N8HM, conduct a live demo.

Patrick J. A. Gowen, G3IOR (SK)

Ray Soifer, W2RS

Pat Gowen, G3IOR, of Norwich, Norfolk, passed away on August 17, after a long illness. He was 85. The amateur-satellite world has lost one of its true pioneers.


Pat was a co-founder of AMSAT-UK, and was elected to the board of directors of AMSAT-NA in 1974. He was also the longtime satellite columnist of Practical Wireless, as well as a frequent contributor to The AMSAT Journal and Oscar News.

He was the first to work 100 DXCC entities via satellite (all LEOs), and received Satellite DXCC No. 4 when his QSL cards arrived. Fluent in Russian, Pat enjoyed conversing with the cosmonauts aboard MIR and ISS.

He and I made the first transatlantic QSO between two handheld transceivers, in 1991. More recently, Pat was the first to discover the "re-birth" of AMSAT-OSCAR 7 when its battery returned to life in sunlight.

In addition to his work with AMSAT and satellites, Pat was a prominent HF operator and DXer. He had confirmed QSOs with all DXCC entities and had also been a member of the First Class CW Operators Club (FOC), as well as a leading member of the Norfolk Amateur Radio Club. Literally hundreds of new amateurs obtained their licenses as a result of Pat's NARC training classes.

Professionally, Pat was a biochemist, retired from the University of East Anglia. He had also served as a magistrate in the Norfolk courts, the youngest in England at the time.

No mention of Pat would be complete without noting his decades of work in cleaning up the beaches and waters of his beloved Norfolk. He leaves his wife Norma, a noted landscape artist. 



AMSAT News Chirps

November Satellite Activity Planned for HC8 Galapagos DXpedition

HC8, GALAPAGOS ISLANDS. An Argentinian group will be active as HC8LU from San Cristobal Island in the Galapagos Islands between November 29 to December 8, 2017.

Operators include Alejandro, LU8YD, Alejandro, LU9VEA, Mario, LU7VB, and Patricio, LU3YK. Pilot stations are Sergio, LU7YS, and Javier, LU5FF.

Activity will be on 160-10 meters using mainly SSB and Digital modes (WSPR, JT65, FT8, PSK31). Also operations on the satellites (LEO, FM and SSB). QSL via IK2DUW. Visit their Blog page for updates, at: hc8lu.blogspot.com.ar


Skeds Wanted for AO-7

John Papay, K8YSE, sent advice to amateur satellite operators in the northeastern section of North America that Nikolay, UX0FF, is looking skeds via AO-7. John wrote, "He is an accomplished operator and worked satellites years ago. He is an active EME operator and has WAS on 2M. His grid square is KN45kj."

Skeds can be arranged via e-mail using the address listed on Nicolay's QRZ.com page.

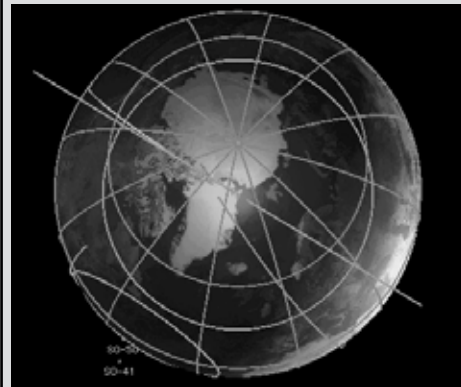
On September 17 KB1RVT and UX0FF completed a QSO on AO-7. This was Nikolay's first satellite contact with the USA. Nikolay is still looking for others to work in North America.

For the past several months, AO-7 has had a tendency to flip from Mode B to Mode A even in the presence of only modest uplink signals, likely due to poor illumination on the solar panels. As the seasons have progressed, it appears that the illumination situation has improved. Get on and make some QSOs! This would be a particularly good time to set up skeds for extreme range QSOs.

According to DK3WN's illum software, from October 15th through November 21st, AO-7 will be in constant sunlight. During this period, the 24 hour timer will function and the satellite will spend 24 hours in Mode B then 24 hours in Mode A. Get those 10 meter antennas ready! 

MacDoppler

The premier Satellite tracking and station automation application for the Macintosh - OS 9 & OS X



MacDoppler for Cocoa gives you a seat right in the heart of the Operations & Command Centre for every satellite in orbit, providing any level of station automation you need from assisted Doppler Tuning and Antenna Pointing right on up to a fully automated Satellite Gateway!

It will calculate the position and relative velocity of the satellites you are tracking and automatically adjust the Doppler shift on both transmit and receive as well as pointing your antennas with predictive dead spot crossing so that a pass is never interrupted.

A Universal Binary that runs native on Intel and PPC Macs and provides separate panels for the map (2D or 3D), the radio and rotor controls, a sorted table of upcoming satellite passes and a Horizon panel that graphs upcoming passes as a function of elevation over time.

Now available from AMSAT at a special member discount donation!

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The AMSAT Journal Needs Your Words and Wisdom

The *AMSAT Journal* is looking for interesting articles, experiences and photos to share with other AMSAT members. Writing for the *Journal* is an excellent way both to give back to the AMSAT community and to help others learn and grow in this most fascinating aspect of the amateur radio avocation.

Find a quiet place, sit yourself down, get out your laptop or pick up a pen, and ...

1. *Launch* your inner writer;
2. *Downlink* your knowledge and experiences to others by:
 - Sharing your adventures in the "On the Grids" column or
 - Describing your AMSAT career in "Member Footprints;"
3. *Transmit* lessons learned from operational and technical projects;
4. *Log* some of your more interesting passes across the sky; and
5. *Boost* others to a higher orbit of know-how and experience.

After your article lands in members' mailboxes, and the kudos start arriving for your narrative payload, you can enjoy the satisfaction of knowing you've elevated the collective wisdom of AMSAT to a higher trajectory.

Send your manuscripts and photos, or story ideas, to: journal@amsat.org.

Our editors are standing by!

Support AMSAT

AMSAT is the North American distributor of SatPC32, a tracking program for ham satellite applications. Version 12.8c is compatible with Windows 7, 8/8.1 & 10 and features enhanced support for tuning multiple radios.

Version 12.8c features:

- SatPC32, SatPC32ISS, Wisat32 and SuM now support rotor control of the M2 RC-2800 rotor system.
- The CAT control functions of SatPC32, SatPC32ISS and Wisat32 have been expanded. The programs now provide CAT control of the new Icom transceiver IC-9100.
- The accuracy of the rotor positions can now be adjusted for the particular rotor controller. SatPC32 therefore can output the rotor positions with 0, 1 or 2 decimals. Corrections of the antenna positions can automatically be saved. In previous versions that had to be done manually.
- The tool "DataBackup" has been added. The tool allows users to save the SatPC32 program data via mouse click and to restore them if necessary.
- The rotor interfaces IF-100, FODTrack, RifPC and KCT require the kernel driver IOPort.SYS to be installed. Since it is a 32-bit driver it will not work on 64-bit Windows systems.
- SuM now outputs a DDE string with azimuth and elevation, that can be evaluated by client programs. Some demo files show how to program and configure the client.

Minimum Donation is \$45 for AMSAT members, \$50 for non-members, on CD-ROM.
A demo version may be downloaded from <http://www.dk1tb.de/indexeng.htm>

A registration password for the demo version may be obtained for a minimum donation of \$40 for members and \$45 for non-members. Order by calling 1-888-322-6728. The author DK1TB donated SatPC32 to AMSAT. All proceeds support AMSAT.



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

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

AMSAT has an immediate need to raise funds to cover both the launch and related expenses for Fox-1Cliff and Fox-1D. We have set a fundraising goal of \$125,000 to cover these expenses and help us to continue to keep amateur radio in space.

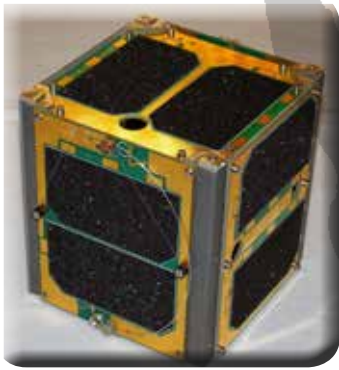
Fox-1Cliff will launch on Spaceflight's SSO-A dedicated rideshare mission aboard a SpaceX Falcon 9 scheduled to launch from Vandenberg Air Force Base in California in late 2017 or early 2018.

Fox-1D will ride to orbit on an Indian PSLV vehicle scheduled to launch from Satish Dhawan Space Centre in Sriharikota, India in late 2017.



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

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



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

Your help is needed to get the AMSAT Fox-1Cliff and Fox-1D IU Cubesats launched.

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.

- | | | |
|---|--------------------------|-----------------|
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| | <input type="checkbox"/> | \$4800 one time |
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AMSAT is Amateur Radio in Space ... and YOU are AMSAT!

Seize 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 Engineering Team

AMSAT Engineering is looking for hams with experience in the following areas:

- Attitude Determination and Control, and Thermal Engineering, to help in the design of high orbit CubeSats.
- Power systems, for CubeSats from 1U through 6U and LEO to HEO.
- Help with solar, power supply, and battery design for both LEO and HEO missions.
- Logistics, for parts procurement, inventory, and distribution.
- Documentation, for designs, tests, and public relations.

To volunteer, please describe your expertise using the form at www.amsat.org/contact-amsat.

AMSAT User Services

AMSAT is looking for an on-line store co-manager to update and refresh the AMSAT Store web page when new merchandise becomes available or prices and shipping costs change.

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

To volunteer, send an e-mail to Joe Kornowski, KB6IGK at: kb6igk@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 Joe Spier, K6WAO at: k6wao@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 Gould Smith, WA4SXM at: wa4sxm@amsat.org

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