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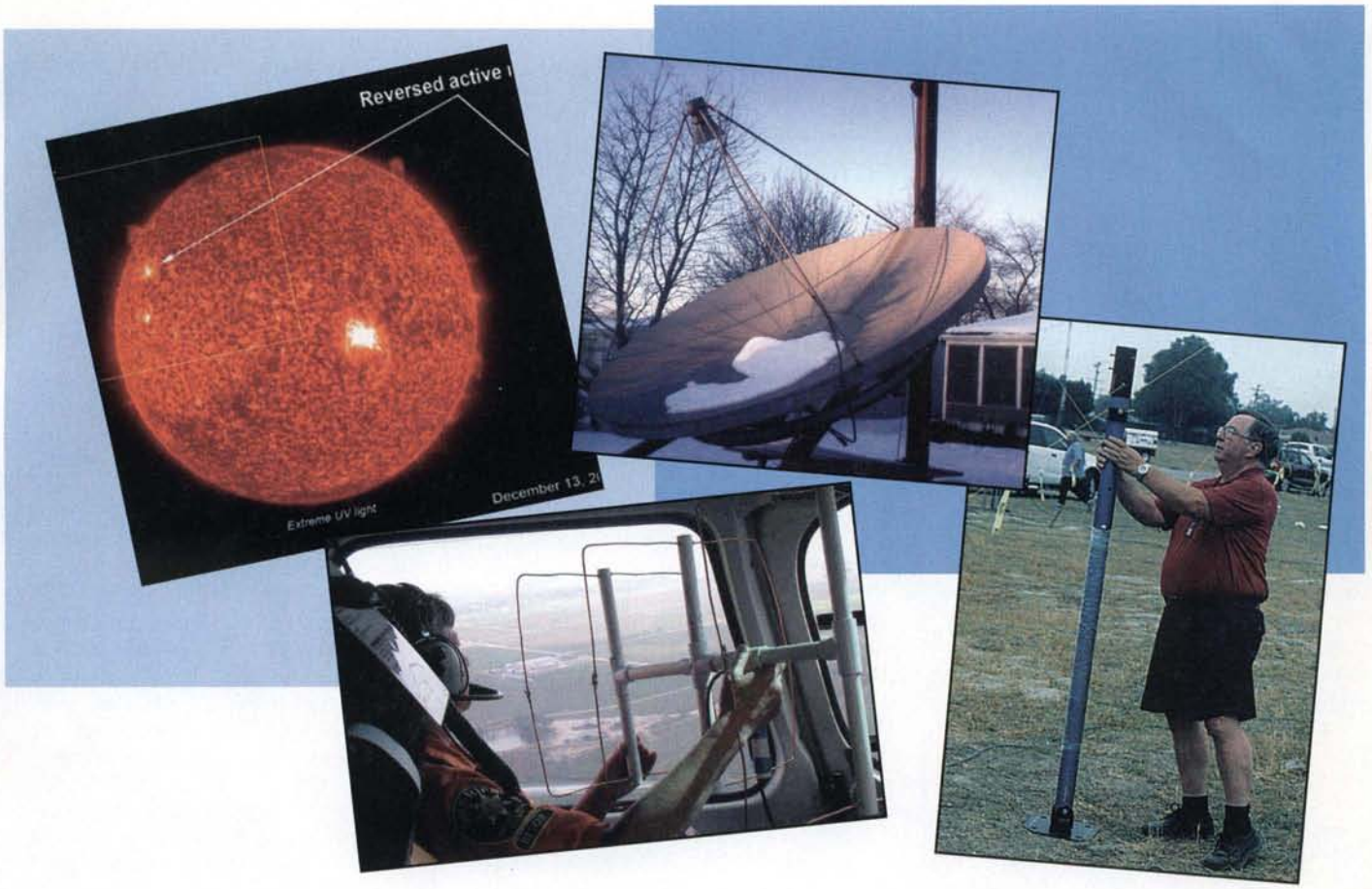
FEATURES



COLUMNS

DEPARTMENTS

On The Cover: This time we feature a montage of just a taste of the articles and columns in this issue. For details see the following: The features "Cansat" by KD4HBO on page 20 and "Launching Dreams" by KB3NMS on page 6; and the columns "Homing In" by KØOV on page 47 and "Up in the Air" by WB8ELK on page 79.

CQ VHF Ham Radio Above 50 MHz

LINE OF SIGHT

A Message from the Editor

Amateur Radio is Still an Adult Hobby

In her December 2007 *Reader's Digest* "Money Makers" column, Maria Bartiromo writes about a successful startup company directed at children and cell-phone usage. Titling her story "The Will to Succeed," she features Daniel Neal, who got his idea to start Kajeet, a wireless service for kids, after observing just how savvy his preteen (nee-tween) daughter and other kids her age were in their use of cell phones. Partnering with Matt Baker and Ben Weintraub, two other dads, together they designed a kid-friendly cell phone that at the same time gives parents needed controls to keep their children safe from bullies (and other undesirable callers) as well as sets curfews so that their children aren't texting during school time.

To get to the final product, they spent two years in R&D, often in impromptu focus groups with their target market. For example, they tell of the story of encountering "tweens" at an airport on a field trip. They turned that "chance" meeting into an opportunity to listen to these kids and their chaperones and parents, who asked their respective questions about the cell phones that Neal and his partners were using. From that discussion and countless others, they developed a full-feature phone with voice mail, games, Internet access, and navigation service, along with text, pictures, and instant messaging, as well as the above-mentioned parental controls.

Bartiromo summarizes Neal's purpose in founding Kajeet as follows:

> Founding Kajeet, says Neal, was about doing the right thing for kids and parents. "I've always thought about technology as a tool that will not only help make our kids more connected but also enable them to be more competitive as the world becomes more interlinked." The challenge going forward, he says, is "to figure out the best way to bring educational content and application to this mobile platform in a way that excites kids about learning" *(page 65)*

It was when I was a tween that I first showed up at the doorstep of my neighbor's ham shack. It all started with my chance encounter with a college textbook on radio and electronics in the day room of the children's home where I lived for a couple of years after my mother's death. My father found that it was impossible for him to care for his children and work full time after my mother's passing. Nazareth House, a Catholic home for children, became the place for us to live until after my father remarried a couple of years later.

Reading that book fascinated me. In particular, I became enamored with wave propagation and antennas. After returning to our home, I spied a tall tower with antennas on it. I located its base, which was at this ham's shack in his back yard. I got the nerve to enter his property and pound on the door. When a man who was older than dirt in my childhood estimation answered the door, I announced that I wanted to learn more about his radio station.

Tentatively, he invited me in. After inquiring about my parentage and where I lived (a block and a half away), he proceeded to tell me about the hobby of amateur radio. After he turned on his Collins 75A4 receiver, he let me listen to it. However, he told me not to touch anything but to just listen.

Unfortunately, I did not listen to that last instruction. No sooner had he turned his back and I was twisting every knob I could get my hands on. Turning around toward me, he was livid. He told me to get out of his shack and not to come back until I could keep my hands to myself. I didn't go back for more than two years.

In the interim I got a new next-door neighbor who was a ham. Spying his call-sign license plate, I went over to meet him. At our initial meeting I announced that I wanted to become a ham. Fortunately, he took me under his wing and mentored me into the hobby by teaching me the theory and having me listen to military training Morse code records. When he deemed me ready, he had me order the Novice exam and administered the test to me.

It was about two months later when my ham license came in the mail. After my license arrived, with it in my hand I made my way back to the neighbor who had previously run me off. When I arrived at his ham shack door, sheepishly, I knocked. When he opened the door, I held up my license in front of my face and announced that I had learned my lesson and was now a ham. Then I apologized for my previous indiscretion and assured him that I would not touch a thing except under his instruction. After my speech, he invited me in and we became good buddies until his death.

My point in telling my story is that I first became interested in the hobby of amateur radio when I was a tween. With the critical help from an adult mentor, I got my license when I was barely a teenager. As a result of ongoing adult mentorship during my tween and teen years, my hobby has become a lifelong pastime that opened the door to my initial career as an electronics technician and now has me editing this magazine.

Even though I had adult mentors who made the hobby tween and teen friendly for my entry into it, thanks to the high interest in the hobby among my peers, I was able to hang out with a number of other fellow ham radio operators my age. Together we designed and built our stations from the rig to the antenna. We worked our DX and made our technology discoveries as youth. Graduating from high school, most of us went on to college and/or a career closely related to the hobby.

Now for the most part we no longer have this mentoring relationship with our youth. As a result, today's tween and teenage hams do not have a large number of contemporaries with whom they can hang out. As Bartiromo illustrates for the cell phone industry by way of her *RD* column, we need the adult involvement with youth in order to once again make our hobby tween and teen friendly. Otherwise, our hobby will remain adult oriented with little hope for future growth from the youth.

Therefore, in order to attract tween and teen newbies into our hobby, we must do for it as Daniel Neal has done for the cell phone—design tween- and teen-friendly access to it. This means that we need to listen to the tweens and teens (as well as their parents) via focus groups—both formal and impromptu—so that we can hear their concerns and meet them with ideas that will attract them at their level of technological development. In doing so, we will also "enable them to be more competitive" in their future career choices.

How do we proceed? In other words, to paraphrase Daniel Neal's words into a relevant question for us, "How can we figure out the best way to bring educational content and application to our hobby in a way that excites kids about learning?" I am open to your suggestions, which I will gladly publish in future issues of this, your magazine. Until the next issue…73 de Joe, N6CL

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Missioner II, a van turned space shuttle, made a five-day journey on the turnpike across Pennsylvania in April 1990. (Photos courtesy of the author)

Launching Dreams

The Long-Term Impact of SAREX and ARISS on Student Achievement

KB3NMS traces the nearly two-decade history of her students' involvement with SAREX and ARISS from their middle school days to their current careers.

By Patricia Palazzolo,* KB3NMS

NA1SS, this is WB4GCS on Primary. . .
NA1SS, this WB4GCS on Primary. . .
Nothing but static.
NA1SS, this is WB4GCS on Secondary. . .

Uh oh! With that exchange my heart nearly stopped! *Secondary* . . . and still no response? What was wrong? The huge room was filled with students, family members, teachers, and members of the media, and all eyes were glued to the wall-size tracking screen. We could see that the International Space Station was in the "footprint" over Pittsburgh, yet we heard nothing. Would the months of preparation leading up to this moment end in disappointment?

Once again came the calm voice of our amateur radio "wizard," Jim Sanford, WB4GCS:

NA1SS, this is WB4GCS on Primary. . . weak but readable . . .

Then we *all* heard it:

WB4GCS, this is the International Space Station, NA1SS. Your signal is getting stronger.

The collective breath released by all, and the brightness of the grins on every face, seemed powerful enough to blast us all into orbit without a shuttle! The excited students began their Q&A

**1415 Rostron Drive, Pittsburgh, PA 15241*
(Printed courtesy of AMSAT and the author, this article was published in the 2007 AMSAT Symposium Proceedings.*)*

with Expedition 9 astronaut Mike Fincke, but in fact the opportunity for this exchange had its beginnings 15 years earlier with an entirely different group of eager middle schoolers.

Orbiting the Turnpike

Back in 1985, over 11,000 teachers completed lengthy applications in hopes of becoming NASA's first "Teacher-in-Space." After a long and grueling selection process, two teachers were chosen to represent each state and U.S. territory. I was thrilled to be selected as one of the two Pennsylvania representatives. I was assigned to the same training group as New Hampshire teacher Christa McAuliffe; after Christa's eventual selection as America's Teacher-in-Space, I was both pleased and honored that NASA appointed the remaining state finalists "Space Ambassadors" and assigned us the task of promoting aerospace education in our home states. In the months leading up to the *Challenger* launch number one, like the rest of the Teacher-in-Space finalists, I received requests to drive ever farther to conduct school assemblies, run teacher workshops, and give speeches. The public was definitely caught up in the dream. The nightmare came that January.

3—2—1—Liftoff! I watched *Challenger* rise, brighter than the sun, into that clear blue sky and heard the voice of the public affairs officer come over the loudspeakers at the viewing site: *Obviously a major malfunction . . . the vehicle has exploded.*

I returned to Pennsylvania to find a blur of phone calls, cameras in my face, and questions—questions as to possible damage to children's psyches, whether the Teacher-in-Space Project had been nothing more than a public-relations stunt, and whether we should be spending any money at all on the space program. What I did *not* return to find was any lack of the ability of space exploration to continue to inspire students and teachers.

And so it was on a warm spring day in 1989 that I received a phone call out of the blue from Mary Ellen Chuss-Mirro, a dynamic teacher in the small Sacred Heart School in the town of Bath on the opposite side of Pennsylvania. She had read that I was "NASA Space Ambassador" to the state and wondered if I had any ideas for "experiments" her middle school students could conduct to keep them busy so they would not "drive her husband crazy" while he drove them around the Bethlehem Raceway on a two-hour "mission" in the van that they had converted into a "space shuttle." I came up with several suggestions, and intrigued, called her back several weeks later to find out if the mission had been a success. Delighted with the outcome and bubbling with enthusiasm, she said her only concern was that she did not know how she would top it the following year.

"I do," I said. "Come on a mission across the entire state! My students will serve as mission control for your orbiter!"

The detailed planning would have made NASA proud—police escorts set up along the way, stops arranged at various venues on the route (including a special welcome by the governor in Harrisburg), experiments designed, a special "rover" built to be used to explore "Planet Pittsburgh" upon the crew's arrival, and computer tracking programs written by my students so they would be able to provide hourly reports to our entire student body about the location, speed, fuel consumption rate, and likely "landing" time of the "orbiter," known as *Missioner II.*

A real coup on our part, or so we thought, was having secured the use of a cell phones for the duration of the mission across the Commonwealth. At that time, very few "average people" had ever used, let alone owned, a cell phone. We were grateful to the company that donated the equipment and usage time of this "new-fangled" high-tech device that would help our mission control stay in touch with the van turned shuttle.

After a year of preparation, *Missioner II* blasted off on April 30, 1990 and began its five-day journey across Pennsylvania. For much of the mission, cell phone was useless. Fortunately, a couple of local hams, Seth Ward, KC3YE (SK), and his son Glenn, N3EKW, graciously volunteered to serve as our back-up communications system.

Not only was their ability to communicate with the van turned shuttle instrumental to the mission's success, it provided excitement and a genuine "mission control" feel to our site. The students loved seeing the radio equipment and hearing the details of the orbiter's progress across the state over the speakers. As the "shuttle" drew closer and closer to Pittsburgh, we began to hear other hams talking about it over the radio: *Did you just see that? Is that a space shuttle on the turnpike?*

On "final approach," I was a bit concerned about *Missioner II*'s clearance coming through one of Pittsburgh's famous tunnels. After hearing our ham radio volunteers discussing our tunnel situation, a ham listening in from a station in a rival school district could not contain his curiosity. He called to ask us just what we were trying to bring in through the tunnel. He had assumed it was some kind of big truck until he heard the words "wingspan" and "tail height." Our students got a good laugh when they heard him joke, "That's Upper St. Clair for you . . . always having to show off!"

The excellent work of our amateur radio volunteers saved the day. Our eighth grade mission control team was able to track the shuttle to a perfect landing at our front entrance. The entire school stood outside to cheer the arrival. It was indeed an amazing sight as it moved down the street with a motorcycle police escort firing 40,000 cubic feet of non-toxic smoke out of the main engines! (Yes, the firing of the main engines should not happen during a landing, but the middle schoolers who had been meticulously tracking an unseen object for almost a week wanted to see smoke and hear noise at the end.) *Missioner II* impressed even former astronaut Joe Allen, who was kind enough to join us for the event. (My "mission control" students had met him when they won a trip to the Hubble launch for their design of a shuttle experiment about soap-bubble kinetics in microgravity.) He grinned, patted its wing, and called hit a "really slick vehicle." The help we received from ham radio volunteers in tracking the van turned shuttle led to my next generation of students tracking the *real* thing just four years later.

From Mars to the Stars

During the same period I was working with the teacher in Bath on plans for *Missioner II*'s journey across the Commonwealth, I was contacted by visionary community members from a town much closer to Pittsburgh—Mars (yes, Mars!). Mars is about a 45-minute drive north of Pittsburgh, but at that time was rather rural in nature. The members of the Mars Area Foundation for Education Enrichment (MAFEE) contributed funds to provide special educational and cultural experiences to help their students realize that they were part of the world.

What special experience did the students seek? They wrote to then Soviet leader Mikhail Gorbachev to inquire, "Wouldn't you like the Russians to be the first to visit Mars, Pennsylvania, that is!" Never believing that they would actually receive a response, they were stunned by the arrival of a brief telex stating only that "Cosmonaut Hero Sergei Krikalev will visit the children of Mars in three weeks."

The students then wrote to NASA and said, "You're not going to let the Russians beat us to Mars, are you?" And so it was that Astronaut Mario Runco, Jr. joined Cosmonaut Sergei Krikalev for the first U.S.-Soviet mission to Mars (Pennsylvania!).

So it was, too, that I was called upon to serve as a true "Space Ambassador," especially when Sergei arrived alone and had no return ticket on Aeroflot, we had no translator available, and the nation he came from was still known as the USSR. Everyone was so grateful to have him as a guest for an entire week, but so nervous about making mistakes. We need not have been concerned. From making school visits to attending Pittsburgh Pirate games to serving as the grand marshal of a community parade, Sergei charmed us all.

Therefore, everyone took interest in his next mission on Mir. He was, after all, "our" cosmonaut. It was May of 1991, one year after our special shuttle-van-across-Pennsylvania event. My students who had, as eighth graders, served as mission control were now nearing the end of their first year of high school. They all had maintained their interest in science and technology, taking high-level courses and volunteering at the science center. By this time, encouraged by our amateur radio volunteers, I had earned my own ham license.

In May of 1991, the students were excited to know someone on Mir, but that excitement turned to worry when the Soviet Union disintegrated and stories of Sergei Krikalev being "stranded" in space made headlines. I was able to see him at the Association of Space Explorers Conference in Washington, DC in the summer of 1992, not long after he had finally returned to Earth as "the last Soviet citizen." The first thing he said to me was "Mars . . . the children?" He realized that the students he had met during his visit might indeed have been concerned about his welfare. He smiled when I gave him a chocolate space shuttle made by a Pittsburgh-area candy company to take back to his little girl. I assumed that our paths would never cross again.

It was the following summer when an amazing set of circumstances came together. I learned about the opportunity for students to speak with astronauts aboard the space shuttle through a program called SAREX. I now knew some wonderful people in the amateur radio community who might be willing to help, and I found out that the first Russian ever to fly on the American space shuttle was to be, of all people, Sergei Krikalev. Best of all, in spite of an incredibly tight schedule, Sergei's mission, STS-60, was to be a SAREX mission. There was just enough time to get an application in! There would be no guarantee that my proposal would be accepted, let alone assigned STS-60, but it was worth a try. For equipment and technical support, I turned to the North Hills and Butler Area Radio Clubs. I then approached the Mars Area School District with an offer I hoped they could not refuse: I would do all the work in writing the proposal, finding volunteers, and planning the event—if they would allow me to propose a joint effort between my school district and theirs. Half of the question askers had to come from my district, yet set everything up in Mars. (My own district never did quite understand why I based the event in Mars, rather than my own school. I explained to them that part of the SAREX application required explaining how one would attract the media. How could anyone resist headlines proclaiming that the shuttle had contacted "life on Mars," not to mention the fact that the first Russian to fly on the shuttle had already visited that town?)

The students who had tracked the shuttle van as eighth graders were now high school seniors. I turned to them to design a method of engaging the "new generation" of middle schoolers in SAREX. How could they develop a fair method of selecting the few students who would actually have an opportunity to ask a question? Letters would be sent home to every middle school child in the district. On the *outside* of an envelope, interested students would write the question they would most like to ask an astronaut in orbit. All identifying information, as well as a signed permission slip, would be sealed *inside* the envelope. My team of former students would go through all the questions and pick the best ones. Only then would the envelopes be opened and the identities of the question writers revealed.

I submitted our SAREX proposal . . . and waited.

When our proposal was accepted as one only five sites in the world to be scheduled for a SAREX contact with STS-60, there was joy in both school districts. With the help of some local hams, I began a series of assemblies to excite and inform all the students in both areas about amateur radio and space exploration. In the meantime, my team of 12th graders took their assignment of question selection very seriously. They wanted to be sure to come up with the most important, most interesting, most diverse combination of questions possible. It was their way of passing their torch to this next generation of students.

When the envelopes were opened, we were pleased to find that the "official question askers" included an equal mix of boys and girls. All were excited about the upcoming opportunity. Fourteen students—half from Upper St. Clair and half from Mars, all from grade levels 5 through 8—began to prepare for the big day that would come in February 1994.

The Contact Day

The morning of the contact day was electric. It seemed as if every newspaper and television reporter in western Pennsylvania had descended on Mars Middle School. The "SAREX kids," sporting sweatshirts with a huge STS-60 logo on the front, proudly posed before a large banner that said, "From Mars to the Stars." In between interviews, they practiced reading their questions so as to be prepared when it was their turn to hold the microphone. The school's main office had been set up like mission control and overflow crowds were able to watch the event from the cafeteria and gym on closed-circuit television. Back in Upper St. Clair, the school was open for the public to come in to watch the event unfold on a viewing screen set up in the auditorium.

As the time for contact approached, a call from NASA informed us to which crew member the students would be speaking. "Looks like it's going to be Sergei," said the voice. He could hear the cheer that erupted from the crowd. "I guess they're happy," he laughed.

We all watched the tracking program and saw the shuttle come into the footprint. Nothing. No response to our control operator's call. Tense silence prevailed as the shuttle moved away from the footprint. Finally, the voice from

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NASA told us that "something had come up" with the deployment of the Wake Shield Facility and that essentially Sergei "didn't have his ears on." I was proud of the students' response. They smiled bravely and told the media it was still exciting just to hear the radio attempts. I knew they were disappointed, but part of their preparation had been to learn that SAREX was considered *secondary* to other shuttle experiments and operations, and that a school would only have one opportunity for contact no matter what interfered, including other things that might come up on the shuttle.

However, as we stood there, we heard the voice from NASA say, "Sergei would like to try again on the next pass, if you don't mind missing 90 more minutes of school." This time the cheer was even louder. The contact with Mars was being made via telebridge, so we actually were receiving the signal by bridge to a ham operator based in Australia and could thus wait for the shuttle's next pass.

The hour-and-a-half zipped by. Soon we heard our control operator calling the shuttle once again, and once again there was no response. Wait. . . was that something? Perhaps. Lots of static. . .no. . . the shuttle was out of range. The disappointment was palpable this time. (We later learned that the experts had a theory that the problem had something to do with a huge aurora.) Still, the students exhibited great dignity and maturity as they spoke of how it had been a "great learning experience."

At 11 o'clock that night my phone rang. It was my SAREX mentor wanting to know if we would like to give it an unprecedented third try in about 15 hours!

I frantically began calling 14 families at midnight, trying to make arrangements for everyone to return to Mars in the morning. I made calls to the media, the volunteers, and to our dear control operator, who lived almost two hours away. Everyone was willing to return.

In the morning we woke up to an ice storm! The Mars school district was closed, and my own had a two-hour delay. I kept in mind the poster I had hanging in my classroom: "You never fail unless you stop trying." There was no huge audience this time, but the amazing principal in Mars was able to get the Mars SAREX students in via police escort. Our wonderful control operator took a day off from work and braved the two-hour icy drive to set up the radio, and even a limited number of media returned. Unfortunately, there was no way to get my own SAREX students safely to Mars. The roads were just too bad. Then I had an idea.

I called the Johnson Space Center and asked if my kids could be patched in via speaker phone. At first they did not like the plan, believing it would be too difficult to have first a student from Mars ask a question, followed by one from Upper St. Clair. The delay would be too great and it would be too confusing. I asked them to just please let us try.

After testing the acoustics from various points in the classroom, Houston said the sound was the best when the speakerphone was placed on a chair near my desk.

As the shuttle approached the footprint (which we could not see because the equipment was in Mars), my students, on their knees, gathered around the chair, waiting for their turns to scream their questions into the speakerphone. Their parents formed a ring around them. There was no media. We waited tensely. Then we heard the response for which we had been hoping: *This is U5MIR.*

It was Sergei! This was followed by the first question, posed by one of the "Martians." My student shouted her question into the phone as soon as Sergei had completed his answer to the prior question. The back-and-forth system was working well until my school began dismissing buses early due to the increasingly bad weather. *Bus 43 . . . Bus 71. . .* came over the PA system. The people in Houston informed us that they were hearing our bus announcements and threatened to cut us off. At that, some parents grabbed mousepads to tape over the speakers in the room while others raced to the main office to ask the principal to cut the announcements. The student questions continued successfully. At one point, a woman took Sergei's place in answering. It was difficult for him to make out children's voices, in English, over a less-than-ideal sound system.

Having the opportunity to speak with both Cosmonaut Sergei Krikalev and Astronaut Jan Davis on the first Russian-American shuttle flight was indeed very memorable! It was also a very special example of adults modeling persistence and teamwork for students. From the ham volunteers to the school administrators to the astronauts themselves, it was obvious that the willingness to be flexible and work hard could make important dreams come true!

The Next Generation:
John Glenn, Sea Monkeys, and Ch-ch-chia!

My special group of seniors felt good about having played a role in exposing my new generation of students to the wonders of science and technology. They headed off to college: Francesca to Georgetown with hopes of medical school, Noah to Notre Dame with plans for medical research, Kevin to USC for computer engineering, Amy to Cornell to study planetary science and earth systems, Joe off to Villanova for chemistry, Mike on to Michigan as a physics major, and others off to similar pursuits. As they departed, they kidded me. They had tracked a shuttle mock-up on the turnpike. My next group of students had communicated with the genuine orbiter. What

The logo of the next generation of students: "Let Our DREAMS Take Flight." DREAMS stands for Doing Real Experiments Adds Meaning to Science.

was to follow? Would my next students get to go into orbit themselves?

Not exactly, but thanks to the continued efforts of this "first generation" of students, my new group did get to send a little piece of Upper St. Clair into orbit. Over my many years of teaching, I have witnessed the imagination, learning, and accomplishments of my former students ripple out to touch others in wider and wider circles, like the rings of water from the proverbial pebble tossed in a pond. Amy continued to follow her passion for space science through college. At one point, while attending one of the very selective summer NASA academies, she became friends with a grad student who had designed a ratchetless wrench that was going to be flown as a shuttle experiment. He had just a tiny bit of space remaining in his container and was musing about "some teacher" perhaps being able to have kids think of what to do with that space. Amy immediately responded, "I know just the teacher! I know just the kids!"

I received a phone call from Amy the very last week of school and was told that we had one week to try to design an experiment for that small bit of "leftover space," and that experiment had to meet all of NASA's requirements or we would lose the opportunity. In short, my students had to operate as real scientists.

At first, my middle school students had difficulty understanding that the experiment would be loaded into the shuttle during the summer and sit there for at least two months. Thus, no, they could not send up anything that was alive and our allotted space was just a few test tubes. They finally hit upon the idea of sending Sea Monkey (brine shrimp) eggs, since they would be able to "bring them to life" after their time in space. However, they also wanted to send some flora along with their fauna. Suddenly, one of the students started singing the "Chia Pet" jingle: *Ch-ch-chia. . .Ch-ch-chia!* Why not? One never seems to see them for sale except at holiday time, so they must store well. The experiment design began in earnest, with the students working through much of the summer to meet NASA's standards. The most memorable was the day they were actually able to load their experiment into the special container NASA had sent us, and to place the mission patch they had designed on that container. The patch depicted both a Sea-Monkey logo and Chia Pet sheep, as well as the students' own motto: *Let Our DREAMS Take Flight,* with "DREAMS" standing for "**D**oing **R**eal **E**xperiments **A**dds **M**eaning to **S**cience."

Throughout the design process, the students had only known that their experiment would fly on "a" mission. It turned out to be *the* mission of 1998: STS-95, 77-year-old John Glenn's return to space. That being the case, my little team received far more than their "15 minutes" of media attention. Nevertheless, the stars in their eyes were not so bright as to dim their excitement at viewing the launch and feeling humbled in realizing that something they had put together was indeed being carried into orbit.

As for Amy, now starting her Masters in Science, Technology, and Public Policy at George Washington University, it was another ripple in the pond. The students involved in this project began high school on fire and took advantage of every science and engineering opportunity throughout the next four years. When they were high school seniors, they finally had the opportunity to meet John Glenn and his wife Annie in person during the cou-

ples' visit to Pittsburgh. The Glenns generously spent half an hour with us privately. As I watched these students speak to Colonel Glenn, I realized that their resumes now included Governor's School for the Sciences, several national awards for science and engineering projects, important summer internships, Eagle Scouts, and even the collection and refurbishment of 30 discarded wheelchairs that were then sent to hospitals in Vietnam. They all had been awarded scholarships to top universities, with one even having already been accepted for a full ride to medical school, and they had not yet officially graduated from high school!

The Adventure Continues: From SAREX to ARISS

Early in 2004, yet another opportunity presented itself. I received a voicemail message at school asking me to call NASA—something about being a "crew pick" for an ARISS contact. What did that mean?

As it turned out, Pittsburgh astronaut Mike Fincke was going to be the Science Officer for Expedition 9 on the International Space Station, and he had selected my school with which to make an ARISS contact! I was thrilled, yet confused. I had never met Mike Fincke and he had never attended Upper St. Clair Schools. How did I get to be his "crew pick"? Why wasn't he going to do an ARISS contact with his own school? Was this a prank?

I soon learned that it was a genuine opportunity! Col. Fincke had promised an Upper St. Clair grad working in life sciences/countermeasures at the Johnson Space Center that if he ever had the chance to go into space, he would make a school contact with the school of her choice. When his flight assignment came, he remained true to his promise, and of course she selected her alma mater for the contact. Although this particular young woman, Lesley Lee, had graduated before I began teaching in the district, she was aware of the kinds of special projects my students and the supportive community had been able to pull off over the years. This project would definitely require skill to be a success, because unlike the SAREX, which had been difficult enough to accomplish in Mars, this would *not* be a telebridge. This was to be a "direct." Add to that the Upper St. Clair landscape, where every building is built into a hillside, and my concerns over finding a way to set up an antenna to clear both buildings and trees grew serious. For that matter, where could I even find someone with the right antenna? Where could I find someone who could set up the correct equipment?

I turned to my local amateur radio club, WASH, the Wireless Association of South Hills, which in turn engaged the cooperation of WACOM, Washington Area Communications. Their energy, passion, commitment, and expertise were boundless even as the contact date kept slipping and everyone had to keep changing their vacation dates. They took over everything having to do with the setup, from stringing wire through the school roof, to splashy camera and sound setups, to T-shirts! All I had to do was deal with the students.

This time, instead of middle school, I wanted to involve a range of ages of children. The students selected to ask questions represented each grade level from fourth through twelfth. I named them the "ARISS Ambassadors," and informed them that part of their job would be to act as my liaisons to each of their respective classes. I would call upon them to keep their classmates updated on information related to space, science, and technology throughout their years in the Upper St. Clair School system. It would also be my hope that as they graduated and moved on to college and careers, they would continue the ripple-in-the-pond effect of contributing to others, including offering any learning opportunities possible to the next generation of students who would follow them.

. . .This is the International Space Station, NA1SS. Your signal is getting stronger. . .

Jim Sanford, WB4GCS, turned the microphone over to ninth-grader J. T. Gralka, who asked the first question, while Kevin Smith, N3HKQ, prepared the next student to quickly take his turn. I stood offstage to guide each student who had asked a question safely clear of the next child leaving the platform. They were starry-eyed from the experience, and I know that their minds were no longer connected to their body movements. I did not want to see a domino-style pileup of my ARISS Ambassadors! I, too, was dizzy with excitement and grateful that someone was recording Mike Fincke's answers. I vaguely realized that he was responding in ways that ranged from humorous to poetic, but I could not get my mind to register anything beyond "The kids are talking to an astronaut on the ISS! It's really happening!"

I became aware that the students had the same experience when reporters begin to ask them what they thought of the answers to their questions. I almost laughed when I saw the puzzled look in their eyes as they suddenly realized that they couldn't remember what Mike had just told them. It was fine. The details would return to our brains later. For then, it was enough just to bask in the glow of a successful ARISS contact and thank all those who made it possible, just as we did over a decade ago after our SAREX with STS-60. A random thought passed through my mind: After beginning with a contact date of "anywhere between May and September," and through numerous slips of the official date, once we had been given one, we had finally made successful contact on August 27. That day was Sergei Krikalev,U5MIR's birthday.

The Next Generation of Explorers

NASA's new mission has set goals that move beyond simply "inspiring" children to consider careers in science and technology: engagement, education, and employment. It is important for students to seek strong educational foundations in these fields as a means of retaining an interested, well-trained work force, as well as to engage the public in a vision that supports science, technology, and space exploration. Various reports of the monumental number of students, teachers, and the general public who have witnessed, heard, or read about SAREX and ARISS contacts have been issued over the years. I know that after a SAREX or ARISS contact, I have had to send the ARRL reports of "my numbers" in terms of live audience, those watching from satellite locations, teachers who may have been in-service, newspaper article readership, and even the number of those who may have viewed a news story about it on television. Those statistics reveal the tremendous outreach of SAREX/ARISS, and no one can watch the faces of those viewing students talking via amateur radio to an astronaut and doubt the inspiration factor, even those who are simply audience members.

However, it is vital that we consider the long-term impact of that inspiration. The students who were actually selected to

Amy (Snyder) kaminski participating in a NASA Academy as a college student. Today Amy is Space Programs Examiner for the White House.

ask a question, or in some cases to help set up the equipment, are significantly smaller in number than those reported as "audience members." Yet if the inspiration of that hands-on experience at a crucial age can inspire these children to pursue education and enter careers at the passionate and high quality level that I have witnessed among my own former students, then the positive impact of SAREX and ARISS goes far beyond any numbers found in reports. All of my students who participated in SAREX/ARISS—or were the original "mission control" team tracking *Missioner II* across Pennsylvania—have gone on to phenomenal accomplishments and careers that contribute much to society. Almost all have opted for careers in science, technology, or science-related fields (such as MBAs working for technology firms or patent lawyers). There are many medical doctors and information technology specialists. One is now an amazing calculus teacher whose classroom is next door to mine! Therefore, I will highlight just a few examples from each of my "generations of explorers." They now range in age from 12-year-olds to professionals in their early 30s.

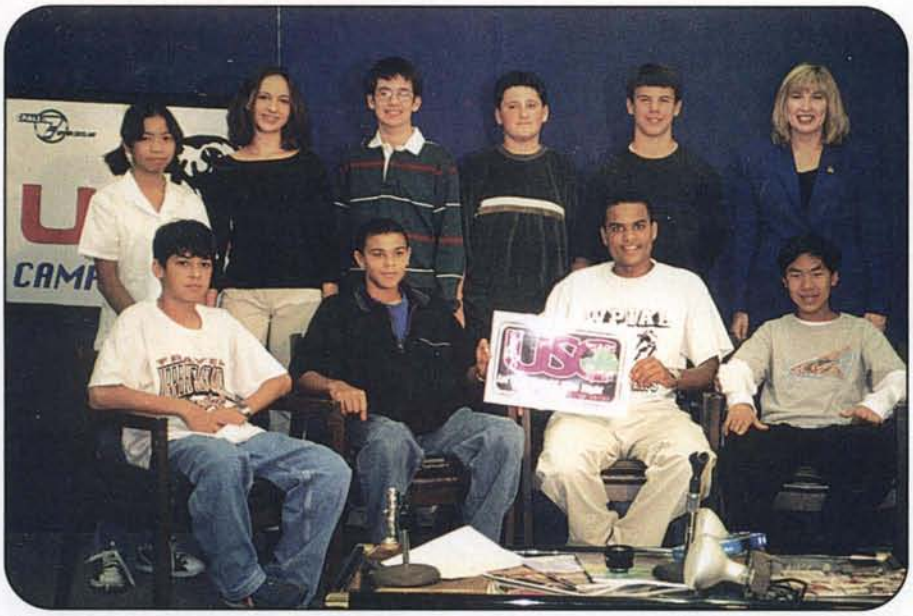
The "First Generation":
Missioner II Mission Control

Noah Gray went on to Notre Dame and then finished a PhD in neuroscience at the Mayo Clinic, where he investigated vesicle trafficking and endocytosis before joining the Cold Spring Harbor Laboratory on Long Island, New York. He later conducted research at the Janelia Farm Research Campus (Howard Hughes Medical Institute), which is the world-class center known for bringing together the best scientists from many disciplines to collaborate on small teams to try to solve some of the world's most challenging problems. He currently is assistant editor of *Nature Neuroscience*, the top journal in its field

Joseph Pickel completed a BS in chemistry at Villanova, followed by a PhD in polymer chemistry at the University of Akron (Ohio). He currently is a polymer chemist at the Center for Nanophase Materials Sciences at Oak Ridge National Laboratory in Tennessee. The center is the first of five nanoscience research centers funded by the US Department of Energy. Joe's research group is dedicated to "making polymers behave the way we want them to" so that they can be useful in fuel cells, making lighter and stronger cars, biomaterials, and more. In Joe's words, "I'm loving it!" Joe has also had to become an expert glassblower, since polymer chemists often have to make the supplies they need for their experiments

Michael Weinberger finished his BS is working for Texas A&M University on the CDF experiment at Fermilab in Chicago, and the CMS experiment located outside Geneva, Switzerland. In his most recent note to me Mike said, "I am in the middle of working right now and am actually underground in France working on electronics for the CMS particle detector as I type this."

Amy (Snyder) Kaminski studied planetary science and Earth systems at Cornell, where she also added a minor in science journalism after having attended a shuttle launch with me with a press pass. She became editor of Cornell's "Science and Technology Journal." Amy received a Masters in Science, Technology, and Public Policy at George Washington University, specializing in Space Policy, while also authoring a book with "space



"Second generation" students eager to see their experimental launch with John Glenn in 1998. Megen Vo is standing on the left, with teacher Pat Palazzolo on the right. Sitting, left to right, are students Matt Muffly, Karl Zelik, Dan Zelik, and Dan Doan.

law expert" John Logsdon. She has published many articles on astronomy, as well as articles on space tourism, and is often a featured presenter at the very NASA Academies she attended as an undergraduate Amy did an internship with the Rand Corporation. She then worked with the FAA Commercial Space Division as the "Office Lead" on both Space Tourism and Space Debris; on the Board of Women in Aerospace; and is featured in a book about 100 powerful woman in the space industry aimed at middle school girls. She currently is Space Programs Examiner for the Office of Management and Budget.

The "Second Generation": SAREX and Sea Monkeys

Megen Vo was featured in the Nickelodeon program *Figure It Out!* The panel had to try to figure out what was so special about the "pets" Megen had brought to the studio in Orlando (flying them in all the way from Pittsburgh). Of course, they were our actual sea monkeys that had been to space with John Glenn back when they were just eggs. Megen currently is in medical school at Case-Western University.

Matthew Muffly was accepted into the Pennsylvania Governor's School for Health Care during high school (a highly selective summer program). He was been a research assistant for a hand surgeon throughout college and has had an article published in the *Journal of Hand Surgery*, He is about to start medical school

Daniel Doan became concerned about problems faced by hospitals in Vietnam, which do not have enough wheelchairs for their patients. For his Eagle Scout project, he rounded up broken and discarded wheelchairs from area hospitals, took classes in how to repair them, and singlehandedly refurbished 30 wheelchairs in his family's garage. When faced with the problem of delivering them to Vietnamese hospitals, he was able to get the World Vision organization to send them. He was granted a full scholarship to undergraduate studies and medical school by the the University of Pittsburgh while still a high school senior. He currently is in medical school

Karl Zelik completed a BS in biomedical engineering at Washington University in St. Louis. He spent undergrad summers working with mechanical hearts in Pittsburgh. This past year he worked developing bionic prosthetics at St. Jude Hospital. He currently is working on his Masters in mechanical engineering at Michigan State.

Daniel Zelik received a full scholarship from Iowa to work on his Bachelors in industrial engineering, with a minor in psychology. As his co-op program, he spent months at a time working with NASA at the Johnson Space Center. He currently is working on his PhD in human factors engineering at Ohio State.

The "Third Generation": The ARISS Ambassadors

Benjamin Burns had perfect SAT scores, but was equally strong regarding civic responsibility. He was on the First Place Design, Engineering, & Fabrication team in high school and nationally ranked as a math student. Currently he is an undergraduate at Harvard studying engineering and physics and also working in the Harvard Observatory.

Matthew Boyas was on the Future Problem Solving Team that qualified to represent Pennsylvania at the Inter-

The "third generation," Sarah Perrone and Matt Boyas with their award-winning Exploravision project.

national Future Problem Solving Finals, where the team finished fourth in the world. He has three honorable mentions from Toshiba for papers submitted for the Exploravision Contest. In January one of those papers is featured in a textbook called *Nanotechnology 101* (Greenwood Publishing group). He has served well as an ARISS Ambassador, including assisting me in running science events for my middle school students. He currently is a high school junior.

Conclusion

After more than two decades and well over 500 successful school contacts, have SAREX and ARISS served to "inspire the next generation of explorers as only NASA can?" Reports that count the number of people "exposed" through these events to science and technology—and, more specifically, to both amateur radio and to NASA—reveal sky-high numbers. However, in this article, a longitudinal case study of one teacher's lengthy involvement with these activities over the course of her career, I have sought to provide specific follow-ups of the students most deeply involved at the time. SAREX and ARISS inspire engagement, education, and employment through:

- Providing "hands-on" learning
- Making real-world connections among disciplines
- Requiring problem-solving while under the pressure of deadlines
- Demanding excellent communication skills
- Illustrating the importance of technology and the joy that sharing one's skills can give to others
- Allowing adults to model the power of passion, partnership, and persistence

My former students continue to work in exciting high-tech fields and continue their willingness to help my current generation of students. Recently, I e-mailed a number of my prior students requesting their help with an educational proposal for a shuttle downlink. The response was immediate and overwhelmingly positive. Mike Weinberger e-mailed me from underground in France, writing: "I hope I am not too late to help with this project. I would love to help out the current students." From Tennessee, Joe Pickel wrote: "I would *love* to take part in this project. . . . please tell me what you need and I will help out."

Last spring, a team of my high school students made the national finals of an academic competition, for which they traveled to Washington, DC. The highlight of the trip was a tour of the White House that Amy Kaminski was able to arrange for them. Even more impressive than the tour in their minds, however, was the fact that it was the "legendary Amy" herself who was accompanying them as they walked through the White House. Amy's willingness to "scramble" on last-minute notice to allow my students to participate in the tour, as well as the willingness of Mike and Joe to fit us into their hectic schedules, have roots, I am certain, that go back to the amateur radio volunteers and others who gave of their time and expertise when these students were so young.

I am but one teacher who is very proud and humbled by the accomplishments of her SAREX and ARISS students over the years. I am especially proud of the lives they have touched and their willingness to "give back." Is there a long-term impact of SAREX and ARISS on student achievement? I am but one teacher. There were well over 200 SAREX school contacts, and there have already been over 300 ARISS school contacts. Just do the math.

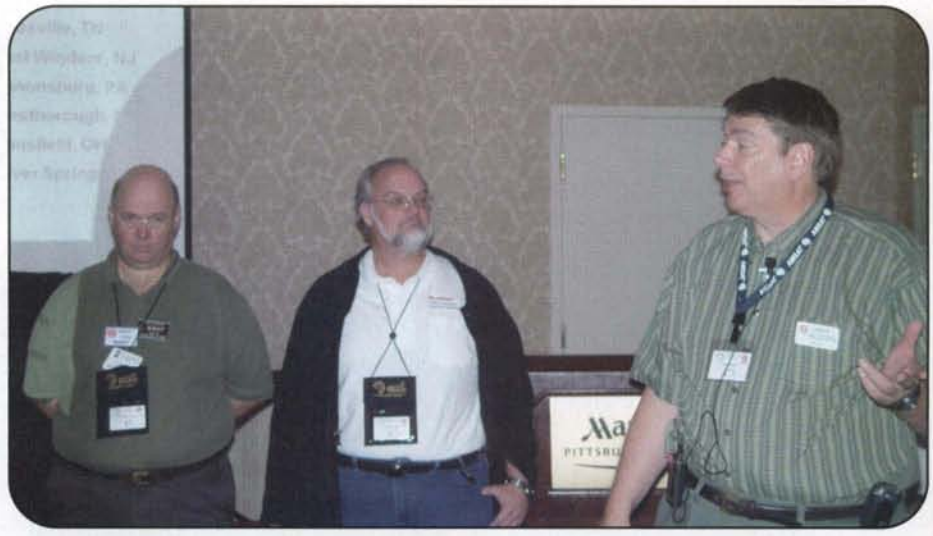
2007 AMSAT Symposium A Report on the Revolution

Since the 2006 AMSAT Symposium, AMSAT's leadership has been working on developing a well-defined mission and vision for the future of amateur radio in space. Here K9JKM reports on the results of the leadership's efforts, which led to several exciting announcements at this year's symposium.

By JoAnne Maenpaa,* K9JKM

"The Conference that would Revolutionize the Amateur Radio Satellite Service." Such was the theme that AMSAT President Dr. Rick Hambly, W2GPS, presented in his welcoming letter, which was published in the *Proceedings* of the 2007 AMSAT Symposium. Indeed, even the venue of the symposium carried the theme of change. Held over the weekend of October 26–28, 2007 at the Pittsburgh Airport Marriott Hotel, which is nestled in the hills of western Pennsylvania, its participants were treated to the vivid change of colors of the leaves of autumn.

As the changing colors of the autumn leaves signaled both a natural end and beginning, so did President Hambly signal both an end and a beginning for AMSAT with two revolutionary announcements: a proposed new geosynchronous satellite and the AMSAT Institute. Other important plans for 2008 and beyond were also announced. They include: the placing on line of AMSAT's Satellite Integration Laboratory in Pocomoke City, Maryland; the expected completion of AMSAT-DL's Phase 3 Express High Earth Orbit satellite; and the beginning of construction and testing of AMSAT's Eagle, its latest High Earth Orbit satellite.



From left to right: Bob McGwier, N4HY, Lee McLamb, KU4OS, and Rick Hambly, W2GPS, discuss technical aspects of the planned geosynchronous satellite. (N6CL photo)

Proposed Geosynchronous Satellite

The most revolutionary and exciting news coming out of the symposium was President Hambly's announcement of a proposed geosynchronous satellite. Hambly, along with Bob McGwier, N4HY, AMSAT's Vice-President of Engineering, made public the results of their recent behind-the-scenes work that will change the playing field of amateur radio satellite communications.

As a result of conversations by AMSAT's leadership with Intelsat (the world's largest commercial satellite communications services provider) concerning their communications satellites carrying our amateur radio satellites into geosynchronous orbit, an agreement between the two entities has been proposed. McGwier indicated that this potential agreement came about as a result of changes in Department of Defense policies which will require DoD-subsidized launches to allow secondary payloads to fill in excess launch capacity of the primary mission.

As if to add to what Hambly and McGwier stated in their presentation, during his subsequent talk "Where's the Launch?" Lee McLamb, KU4OS, explained factors such as the increased size and efficiency of launch vehicles now resulting in excess lift capacity. No longer is it the case that adding weight to the payload means removing fuel (weight) from the booster. Lee added that current missions have 1000–1500 pounds of excess capability of which AMSAT can easily take advantage.

Hambly pointed out that with this new commercial launch reality, AMSAT may actually be able to launch earlier to a high orbit if its satellite fits into the Intelsat ride-sharing model. He added, "We need to be ready for this event."

This new project has been designated Phase IV Lite because of the planned incorporation of much of the Phase 3, P3E, and Eagle satellites' technology in the proposed geosynchronous satellite.

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e-mail: <k9jkm@amsat.org>

Richard Crow, N2SPI, is shown instructing middle and high school students on the construction of homebrew satellite antennas. (N6CL photo)

In discussing the engineering aspect of the proposed agreement, McGwier remarked that while the upside potential is great, many of the technical details still need to be worked out. "Even so," he stated, "there is enough in place at this time that AMSAT needs to begin planning engineering work and possible construction of a geosynchronous payload so we are ready if Intelsat says they have a ride for us."

With the incorporation of technology from satellites already under development, it will be natural for AMSAT to also proceed with the development of its planned easily accessible Earth station which will take advantage of the audio, digital messaging, and video services offered by the resulting advanced communications package (ACP). The details of the ACP appear below under the "AMSAT Eagle Update" heading.

The ACP earth station would be self-contained and would be sent with an amateur radio communications team or delivered to a disaster area in order to supply emergency communications. Such a team would be able to point a small dish at the spot in the sky where the geosynchronous satellite is "parked" and immediately begin providing disaster communication support without depending on HF propagation.

Another feature of the Phase IV Lite satellite would have a direct bearing on the ARISS (Amateur Radio aboard the International Space Station) program. For example, part of the payload could be used to provide a tracking and data-relay satellite system (TDRSS)-like relay of the ARISS communications via the Intelsat system of satellites. The advantage to the ARISS program is that a previously hopelessly short ARISS QSO could last for hours, thereby opening the possibility of student involvement with experiments onboard the ISS.

McGwier also pointed out the advantages of Intelsat geosynchronous platform. One advantage is that Intelsat's primary payload would perform the geosynchronous transfer orbit (GTO) boost phase as well as perform station upkeep and antenna pointing once it has arrived in its orbit. Furthermore, Intelsat can drop off sub-payloads into low earth orbit (LEO), GTO, or geostationary orbit (GEO) on the way to the primary mission. Additionally, the excess power built into the design of the satellite would be able to furnish the AMSAT Phase IV Lite payload with approximately 400 watts of DC power for upwards of 15 years, thereby eliminating the need for AMSAT to provide solar cells.

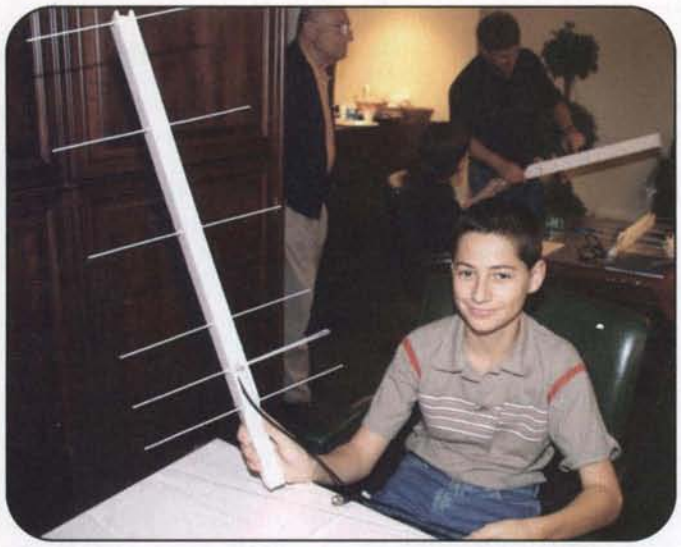
The advantage to AMSAT is that AMSAT does not have to design these features into its satellite. Summarizing his points, McGwier added, "The Intelsat team would be doing all the things nearly impossible for amateurs, thereby enabling AMSAT to do what we do best, that being building a communication system that changes amateur radio for the better!"

New Education Institute Planned

Education, from primary to secondary through higher education, has always been and continues to be one of AMSAT's major missions. It was no surprise then that President Hambly's second major announcement had to do with education. As part of his announcement, Hambly pointed out that AMSAT's cooperation agreement with the University of Maryland Eastern Shore has resulted in an additional educational opportunity.

The agreement already provides the laboratory facilities for AMSAT's new Spacecraft Integration Laboratory in Pocomoke City, Maryland. This laboratory is also a collaborative effort between AMSAT and the Hawk Institute for

The new AMSAT Laboratory in Pocomoke City, Maryland. (AMSAT photo)



This student displays the completed homebrew satellite antenna that he constructed during the N2SPI workshop. Several of the students successfully copied the SO-50 with their newly constructed antennas. (AMSAT photo)

Space Sciences (HISS), also located in Pocomoke, which is on the eastern shore of the Chesapeake Bay.

It was determined that a natural outgrowth of this arrangement could be a venue for training a team of educators in space subjects and satellites. These educators would then branch out and train more teachers to bring AMSAT and amateur radio into their classrooms. This synergistic brainstorming by the leadership of AMSAT, HISS, and the University of Maryland Eastern Shore resulted in forming the AMSAT Institute. The first session of the institute is expected to take place this summer. More information on the AMSAT Institute will be available on AMSAT's website (http://www.amsat. org) as it becomes available.

AMSAT Maryland Lab Update

During his presentation, Bob Davis, KF4KSS, AMSAT's Lab Manager and Assistant Vice-President of Engineering, discussed the progress of finishing the new 8,500-square-foot AMSAT Spacecraft Integration Lab in Pocomoke. As of this writing, the cleanroom is being completed. To date the office walls have been completed, and the laboratory, electrostatic workstations, soldering equipment, and machine shop all have been constructed. The facility will also include a satellite earth station expected to be completed this February. The laboratory will begin to be used with a university Cubesat project in accordance with AMSAT's agreement. Additionally, the Eagle satellite will be built and integrated at this facility.

AMSAT-DL Phase 3E Update

During his presentation, Hartmut Päsler, DL1YDD, Vice-President and Board Member of AMSAT-DL, discussed the current status of the P3E mission. Regarding P3E, Hartmut explained that with international cooperation from AMSAT-NA and AMSAT-UK, it is nearing completion for assembly and testing. With the closing of Research Centre Jülich's Central Electronics Laboratory (ZEL) by the end of 2007 or early 2008 as P3E is completed, it should be ready for launch. AMSAT-DL is currently looking into launch possibilities with Ariane and Soyuz-2. With the announcement of the potential cooperation with Intelsat, additional launch opportunities also may become available.

AMSAT Eagle Update

It was announced that the current baseline plans for Eagle's linear transponders are being expanded into dual-use for Phase 3 and Phase IV application. These features include:

- UHF uplink/VHF downlink linear transponder using Software Defined Transponder (SDX)
- L-band 1269-MHz uplink/S1-band 2400-MHz downlink linear transponder (also SDX)

The details of the Advanced Communication Package (ACP) planned to be used on Eagle and Phase IV are to include these capabilities:

- S2-band 3400–3410 MHz downlink and C-band 5650–5670 MHz uplink (10-MHz segment TBD)
- A phased array with up to 22.4 dBi gain is under study
- Uplink and downlink would be accessible to hams not already on satellites or facing antenna restrictions; a 60-cm dish would work for all users
- Simultaneous development of earth-station package accessible to the average ham
- Earth stations available for emergency communications (EMCOMM) teams and educational outreach (for more information, please see above)
- Probable capacity of 500 text rate, voice-grade channels, and video—scalable data rates depending on the class of the communication application

SuitSat-2 Update

Lou McFaddin, W5DID, described the ongoing design and construction of the communication and experimental payload for SuitSat-2, which hopefully will be deployed in 2008. The SuitSat-2 project will feature:

- Expanded educational outreach
- Linear software defined transponder
- CW ID
- Voice messages
- FM crossband repeater
- SSTV images of the Earth from four cameras
- Temperature sensors
- Room to accommodate four experimental packages
- CD-ROM containing student art and messages

ARISS Continues to Reach More Students

Commenting on ARISS during his presentation, Frank Bauer, KA3HDO, ARISS International Chairman, discussed the seven years of continuous operation of the ARISS program. Bauer summarized the success by citing the statistics of its success. With AMSAT as its key partner in the ARISS program, and the main suppliers of mentors, to date the ARISS program has made over 330 school contacts by 16 consecutive amateur radio licensed crews. It is estimated that the program reaches over 15,000 students per year. While it was announced that because of the workload in December (that now extends into early 2008 with the December 2007 cancellation of the launch of the shuttle *Atlantis*), ARISS contacts will become very scarce for the

Pat Sanford, KC4WTT, coordinated the hosting of the symposium. (N6CL photo)

near term. Eventually, when the workload is caught up, classroom contacts and amateur radio operations aboard the ISS are planned to continue and grow in 2008.

Onsite Youth Education Opportunity

Inspired by their conducting a 2005 ARISS QSO for Upper St. Clair High School, the leadership of the Wireless Association of South Hills (WASH), one of the four host amateur radio clubs for the symposium, has made its mission to work with students. Because of this focus, the leadership of WASH made sure that portions of the symposium were designed to appeal to middle and high school students. To that end, Richard Crow, N2SPI, was recruited to conduct a hands-on educational project during the symposium. Assisted by his wife Sally, KC2CCE, Richard led student satellite workshops. They mentored a group of eager middle school and high school students in building their own satellite downlink antennas, which successfully received SO-50.

Conclusion

Along with WASH, the symposium was co-hosted by the Breezeshooters Amateur Radio Club, Skyview Amateur Radio Club, and Washington Amateur Communications Club, all of the Pittsburgh area. From their seamless cooperation to their *espirit de corps,* their work in bringing about a successful conference was appreciated by all of the attendees. Truly, they set the standard for hosts of future symposiums.

Speaking of future symposiums, the AMSAT Board of Directors has announced that the 2008 AMSAT Space Symposium will be held in October in Atlanta, Georgia. This symposium will be named the "2008 Harry Yoneda, JA1ANG, AMSAT Space Symposium" in memory and honor of Harry, who became a Silent Key on October 8, 2007. Harry was both a former AMSAT board member and a founding member of JAMSAT, as well as a close friend of many in the AMSAT organization. Details on this year's symposium will be posted on AMSAT's website (http://www.amsat.org) as they become available.

In summary, the AMSAT leadership's announcements of new opportunities and the technical discussion inspired everyone. Truly, it was a revolutionary weekend—not only for the Amateur Radio Satellite Service, but also quite possibly for the Amateur Radio Service as a whole.

Cansat: Hands-On Experience Learning about Satellites

In this article KD4HBO expands on an idea that Bob Twiggs, KB6QMD, first thought of in the 1990s, that of recycling soda cans for use in space exploration educational projects.

By Ivan Galysh,* KD4HBO
Stensat Group LLC

Prof. Robert Twiggs, KE6QMD, of Stanford University, developed the concept of cansat in the late 1990s. The purpose of cansat was to allow students to experience a space program on a small, affordable scale. A cansat is a simulation of a satellite the size of a soda can. Students build a satellite that can fit into a soda can and perform some mission. The cansat is launched in a high-power rocket to an altitude such as 12,000 feet and is ejected from the rocket. The cansat floats back to Earth for several minutes, performing its mission and transmitting telemetry or accepting commands to perform specific tasks.

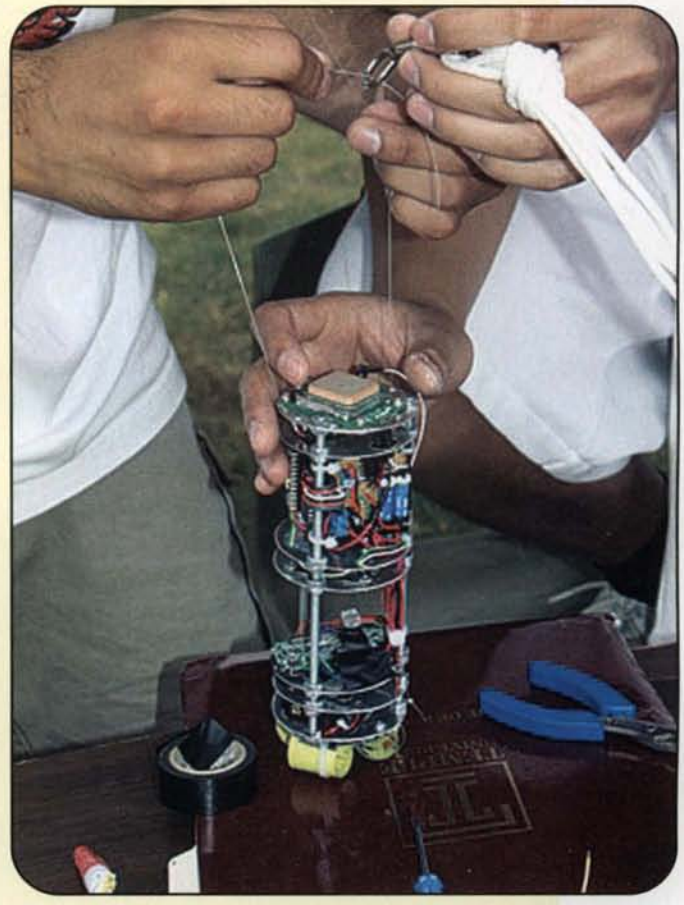
The first cansat launch occurred in 1999 in Black Rock, Nevada. Over time, the cansat concept has spread around the world. It has been used as a stepping stone to the cubesat satel-

**5650 White Dove Lane, Clifton, VA 20124*
(This article is reprinted courtesy of AMSAT and the author and first appeared in the 2007 AMSAT Symposium Proceeedings.*)*

Photos from the third annual cansat competition in Amarillo, Texas. (Photos courtesy of the author)

The electronics inside one of the cansats.

One of the groups ready to launch a rocket with a cansat.



Another cansat.

lite, which was also developed by Prof. Twiggs. Cubesats are picosatellites that can be as small as a 4-inch cube weighing a kilogram.

ARLISS

ARLISS, A Rocket Launch for International Student Satellites, is where cansat started. Every year since 1999, Stanford University, led by Prof. Twiggs and the AeroPac rocket club, has launched cansats up to 12,000 feet for students from various schools, including some in Japan. The launches are held in Black Rock.

The ARLISS launch has been attended by high school and university teams. The event is not a contest, but rather an event providing students with the opportunity to have their cansats launched to high altitudes. The students design and build their cansats to perform a mission they define themselves. The Aeropac rocket club provides the rockets and launch support.

Cansat designs have ranged from simple temperature-measuring devices to robotic types.

National Cansat Competition

In 2004 a university-level cansat competition was created. The competition organizational committee consisted of the American Astronautical Society, American Institute of Aeronautics and Astronautics, Naval Research Laboratory, NASA Goddard Space Flight Center, and the Jet Propulsion Laboratory.

Each year the committee defines a mission for the competition, with the current theme being planetary exploration. Universities around the country apply to be in the competition and start designing their cansats. The teams are required to hold preliminary design reviews and critical design reviews with the committee members, usually by teleconference. In June the teams go to Black Rock and launch their cansats on rockets provided by the competition committee.

The first national competition was held in June 2005 near El Centro, California. Seven teams applied and only three teams came to the launch. The mission was to measure atmospheric pressure and temperature, and to measure the distance and direction from the landing site to the launch site. None of the teams recovered their cansats, which were launched to 5000 feet.

The second launch was held in The Plains, Virginia with the same mission but a lower deployment altitude of 2000 feet. For this event 13 teams applied and seven made it to the launch. Two teams successfully completed the mission.

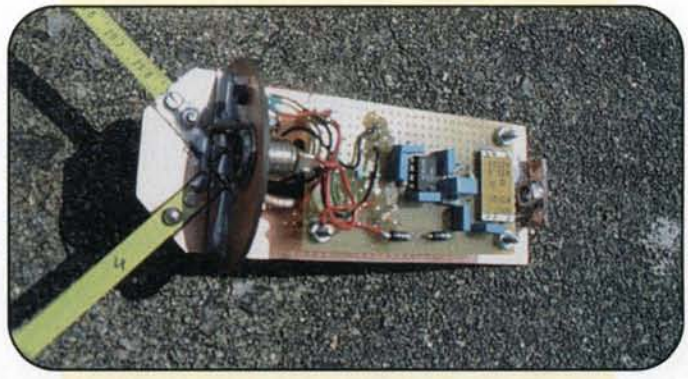
In 2007, the third competition was held in Amarillo, Texas. The mission was changed to require more mechanical and aerospace engineering efforts and less electronics. The cansats had to land and be in an upright position. Twenty-six teams applied and 15 teams attended the competition, including a team from Hawaii. One team successfully completed the mission, with a second team almost completing it. Vegetation was an issue.

Cansat Around the World

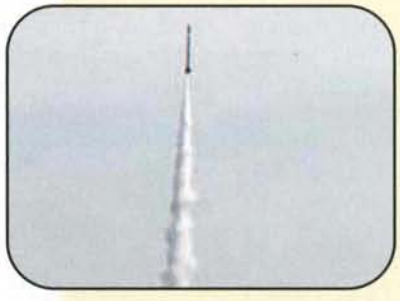
The cansat concept is spreading around the world. The largest organized international event is held in The Netherlands. Delft University of Technology and the ISIS (Innovative Solutions in Space) company have organized a national cansat competition similar to the U.S. competition. Their purpose is to increase interest in exact sciences and technology and enrollment in the Bachelor and Master studies at Delft University. Other organizations involved include The NAVRO (Dutch Amateur Association for Rocket Research), which organizes the launches; DARE (Delft Aerospace Rocket Engineering), which develops, builds, and launches the rockets; and the WO-Sprint fund, which stimulates the competition through its Sprint Program. For the next competition, the winner will travel to the United States to compete in its event. More information can be found at <http://www.cansat.nl>.

Pictures from The Netherlands cansat competition.

Getting ready to track the rocket launches



A PC board inside ofne of the cansats.



A rocket launch.

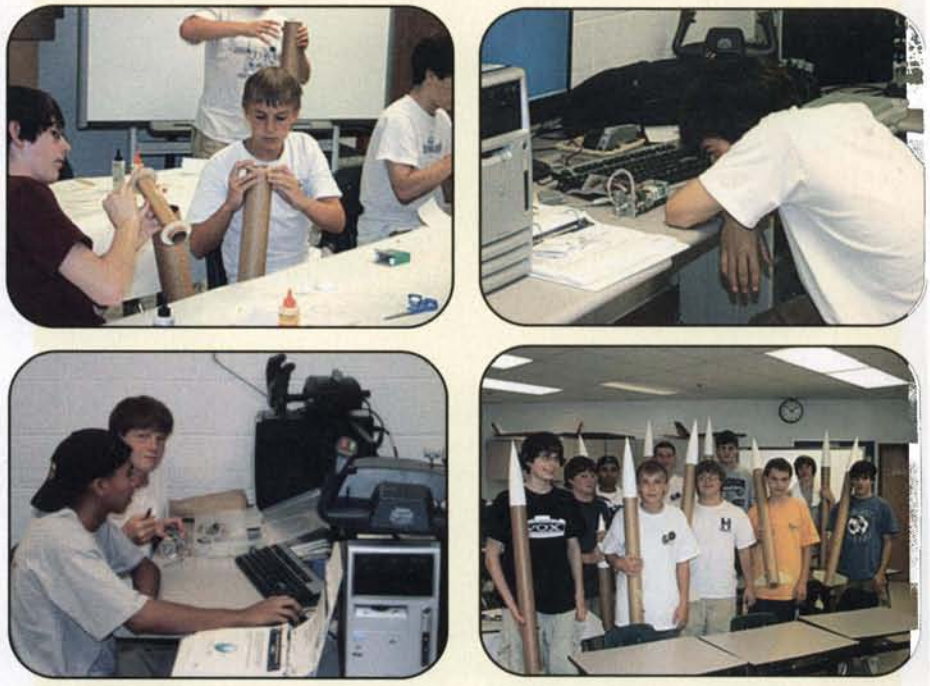
High School Cansat Launch

For high schools that want to attempt simpler missions, a regional cansat launch will be held in Maryland in April 2008. This event is open to high school students only. The documentation is less stringent than for the university competition. The

mission is simpler, but it does require the students to include most subsystems of a satellite in their cansats. The students have to build a ground station. They get to build the rocket to launch their cansat. A rocket motor will be provided at the launch, and the teams will display a poster describing their cansats and missions. More information can be found at <http://www.foge.org>.

Cansat Summer Camp

The Federation of Galaxy Explorers, a nonprofit organization dedicated to teaching kids about space and technology, operates a summer camp for high school students in Chantilly, Virginia. It teaches students about satellites, what makes up satellites, and how they are built and tested. During the week-long summer camp the students work on cansat kits, which include many of the components of a satellite. They also build a 3-inch diameter rocket to launch the cansats.



Students working on the cansats and rockets at the Federation of Galaxy Explorers' sponsored summer camp in Chantilly, Virginia.

During the last camp experience, the first day began with a discussion of the sub-systems of a satellite. The Clementine satellite designed and built by the Naval Research Laboratory was used as an example. Many of the Clementine satellite components were compared with the components of the cansat. The cansat had all of the main subsystems—the aluminum structure, power subsystem, the data-handling unit, communications subsystem, and the attitude determination and control subsystem. The students were introduced to basic orbital mechanics and learned about the different types of orbits. They used the Satellite Tool Kit software from AGI to visualize the different types of orbits and modify the orbital elements to see the effects. The students started assembling the cansat kits and programming the data handling unit.

On the second day, the students continued programming the data-handling unit. By the end of the day, the students had learned how to use the analog-to-digital converter and convert the solar-panel measurements into voltages values. The students also started building the rockets. Each student received a rocket kit. The kit was custom designed by Hangar 11 using Public Missiles components.

On the third day, the students started experimenting with the gyroscope. They installed the gyroscope and wrote software to measure the voltage from the gyroscope. The software then calculated the rotation rate that was linearly proportional to the voltage generated by the gyroscope. The students also learned how to program the data-handling unit to control the radio transmitter. GPS data processing was also performed that day. In the afternoon, the students went outside with their cansats and tested the GPS receivers. During the day the students installed all three fins on their rockets. Fifteen-minute epoxy was used to keep the students from building the rockets too quickly.

Prepping for the cansat launch at the summer camp.

Thursday included final programming, cansat check out, completing the rockets, and preparing them for launch. The students also experimented with a two-axis magnetometer. The magnetometer used a different type of interface called I2C. I2C stands for Inter-Integrated Circuit Bus. The I2C bus was developed by Philips Semiconductors to provide an easy way to connect a processor to peripheral chips. The magnetometer interface behaved similar to a serial EEPROM with an I2C interface. The magnetometer measured the Earth's magnetic field and generated a heading value referenced to magnetic north.

Saturday was the launch day. The launch was held at Great Meadow in The Plains, Virginia, the same field that holds the Team America Rocket Challenge. The students showed up at around 10 AM with their parents. Praxis Inc. provided lunch and T-shirts for everyone. The ground station was set up. One student sat at the computer to monitor the telemetry, and another student held and pointed the antenna toward the cansat. The first rocket was prepared for launch on a G80 motor. The rocket parachute was packed above the piston and the cansat was placed on top. The nose cone with its parachute was then placed on the rocket.

After the rocket was placed on the launch pad, a final telemetry check was made. The rocket was then launched, and the student holding the antenna pointed the antenna toward the cansat as it drifted back to the ground. With little wind, the cansats did not drift very far and were eas-

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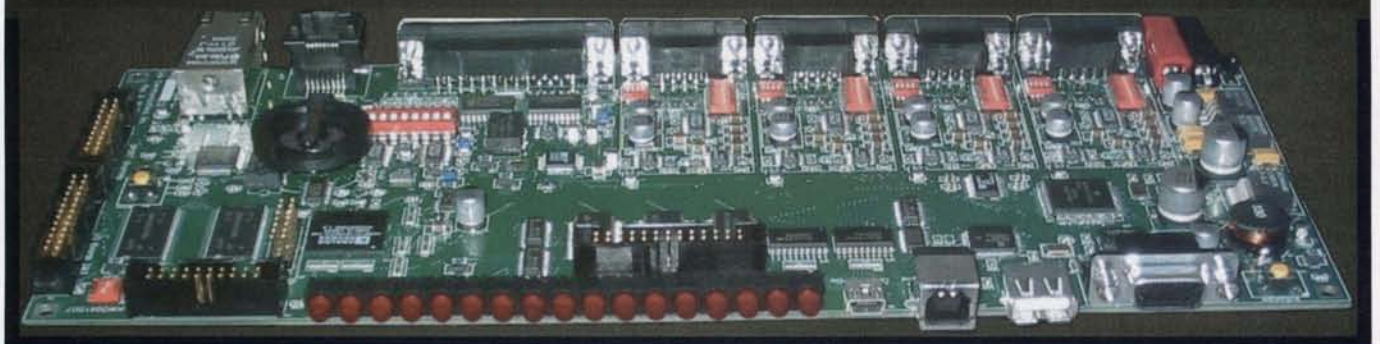

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Radio Ports	4 Radio Ports (expandable to 12) with DB-9 connectors. Individual front panel LED's per port
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Launching a cansat.

ily recovered. All five cansats were successfully launched, although three rockets did crash after deploying the cansats. Some configuration changes to the rockets improved the recovery. One student added a video camera to a cansat. He even built a Yagi antenna. The cansat launch went flawlessly and the video worked. The video wasn't clear, but there were times where the landscape could be seen clearly.

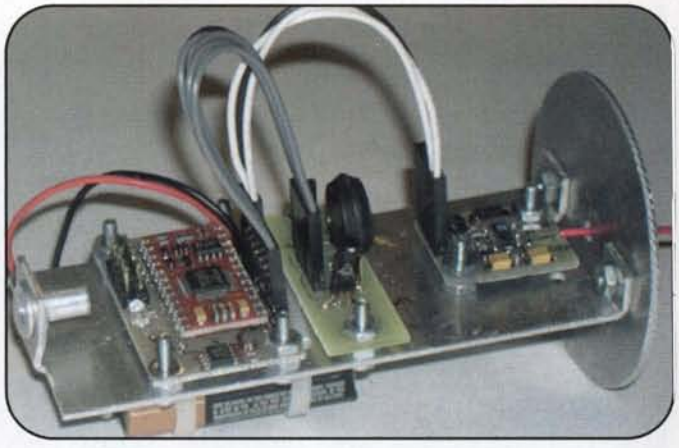
Cansat Kit

Stensat Group LCC developed the first cansat kit. The kit includes everything needed to build a cansat, with detailed lesson material. The mission of the kit is to make atmospheric measurements. The kit simulates a satellite by including many of the subsystems found in a real satellite. Some subsystems are simple, such as a 9-volt battery for the power subsystem. The kit includes a data-handling unit, a transmitter, battery power, an aluminum structure, a parachute for attitude control, and a sensor payload.

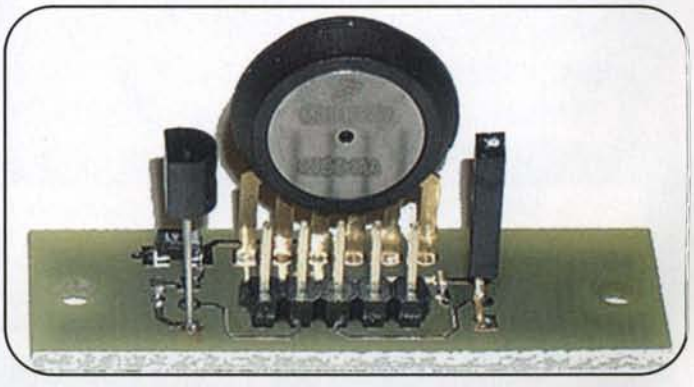
The cansat data-handling unit is a BASIC Micro processor that is programmed in BASIC. The processor includes the development software. The data-handling unit provides three analog-to-digital converter (ADC) inputs for the sensors and a port to connect to the transmitter.

The transmitter operates at 1200 baud using the AX.25 protocol and AFSK modulation. Two frequencies are available, 433.92 MHz and 916 MHz, with a power level of about 10 dBm. The transmitter accepts a universal asynchronous serial data stream and converts the data stream into AX.25 packets. The first version of the cansat transmitter has flown in actual satellites such as GENESAT-1, FCAL, and Libertad. More of the transmitters will be flying soon. Due to a part becoming unavailable, a new transmitter was designed to replace the original. The new transmitter allows for longer packets and can operate at 1200 baud and 9600 baud. It can potentially operate at 38.4 Kbaud. It is currently being designed into new satellite radio systems. A few of the new transmitters have been integrated into cubesat radio boards. The new transmitter can be configured to operate in several bands, such as 6 meters, 2 meters, 70 cm, and 33 cm. The power level is about 10 dBm.

The sensor payload consists of a single board with a pressure sensor, a temperature sensor, and a humidity sensor. All three



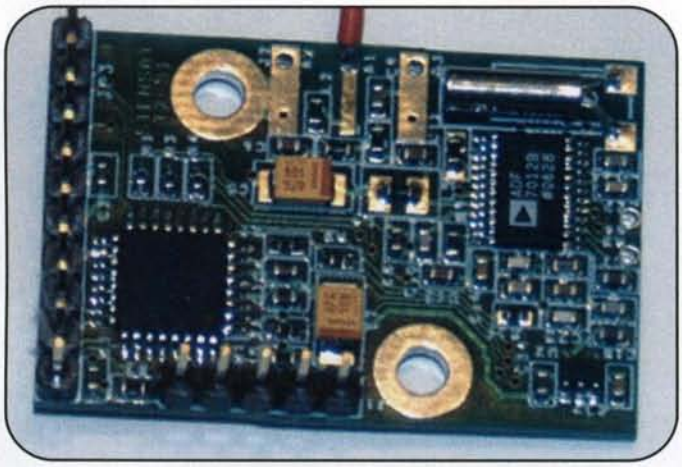
The cansat kit made by Stensat Group LLC.



The cansat kit's sensor payload with temperature, pressure, and humidity sensors.

sensors generate a voltage in proportion to what is measured. The pressure sensor is made by Freescale and has a range from 10 Kpa to 115 Kpa. The temperature sensor measures from 0 to 70°C. The humidity sensor, made by Honeywell, has a range from 0 to 100 percent. To get any significant variation in humidity measurements, the cansat needs to be launched to a high altitude, such as 10,000 feet or more. For significant temperature variation, the cansat needs to be launched to a mile altitude. The data from the pressure sensor can be used to calculate the altitude of the cansat.

The structure consists of a rectangular aluminum plate with mounting tabs. All of the electronics are secured to the plate.



The cansat transmitter.

An aluminum disk is mounted to the plate. This is the stop for the soda can. The top of the soda can is cut off. The soda can slides over the rectangular plate and butts against the disk. A hole needs to be drilled into the center of the bottom of the soda can so an eyebolt can be secured to the rectangular plate. The parachute is secured to the eyebolt.

The lesson material for the cansat is detailed. The material walks the students through each step in assembling the kit and programming it. The lesson material explains how the sensors work and how to calculate the values of the measurements. The students learn about satellite communications and telemetry. They program the cansat to measure the voltages from the sensors and calculate the values. The values are then transmitted to a ground station.

The ground station consists of a receiver and a laptop. The laptop runs a program to decode the AX.25 packets using the sound card. Most students use the AGW software. The receiver can be any ham radio receiver for the 70-cm band. A custom-built receiver is available for the 916-MHz transmitter.

Conclusion

The cansat concept is providing students around the world with hands-on experience in engineering and science. Cansat teaches other concepts besides engineering and science. Students learn to work in teams, communicate with one another, and how to coordinate their time and energies. Based on experiences at the competitions and summer camps, cansat does inspire students to pursue careers in engineering and science. Several high school students from past summer camps have enrolled in universities with aerospace programs.

ARISS Contact with the Arnold Palmer Hospital for Children

Here AA4KN writes of a first for the Amateur Radio on the International Space Station program—an ARISS contact with children who are hospitalized.

By David Jordan,* AA4KN

Since the early years of the Amateur Radio Service, the ways in which our hobby has been of service to others has continuously evolved. These evolutions have included providing phone patches between international parties and providing emergency communications in times of need. Other ways of public involvement with our hobby include introducing ham radio to the public via Boy Scout Jamborees, special event stations, and the like.

One of the more unique ways in which amateur radio has been of service to the public is by way of arranging amateur radio contacts with the public and astronauts and cosmonauts in orbit. These have taken place via the old SAREX (Shuttle Amateur Radio Experiment) program and are now taking place via its replacement, the ARISS (Amateur Radio on the International Space Station) program. Here AA4KN writes of a first for the ARISS program—an ARISS contact with children who are hospitalized.

For 11 of the young patients at the Arnold Palmer Hospital for Children in Orlando, Florida, July 17, 2007 was a memorable day that they will not soon forget. These children had the unique opportunity to ask questions of astronaut Clay Anderson, KD5PLA, on board the ISS (International Space Station) via amateur radio as it made a 9- minute 30-second pass over the United States. This ARISS contact was made possible by way of the initial efforts of AMSAT member John Rothert, KC4IYO. John had been a resident of the Orlando area for many years and the mentor for several ARISS scheduled contacts in the past.

On August 29, 2006, after securing sponsorship from the Lake Monroe Amateur Radio Society (LMARS), John applied for the scheduling of an ARISS contact with a unique institution, a place where this had never been attempted before—a children's hospital—in particular, the Arnold Palmer Hospital for Children in Orlando, Florida. Unfortunately, shortly after application was submitted, John became ill with leukemia and was not able to continue supporting the effort. However, members from the LMARS group carried forward John's efforts by working with both ARISS and the Child Life Department of the hospital in order to make this event a reality.

The Day of the Contact

On the morning of the contact members from both LMARS and AMSAT arrived at the hospital and began setting up for the QSO. Operators on hand were Northern Florida Section Public Information Coordinator Mike Welch, KF4HFC, Bob Pollack, KF4IMF, Lou McFadin, W5DID, and me, AA4KN.

This girl is shown asking her prepared question, "What do you do if you get sick in the space station?" (KF4HFC photo)

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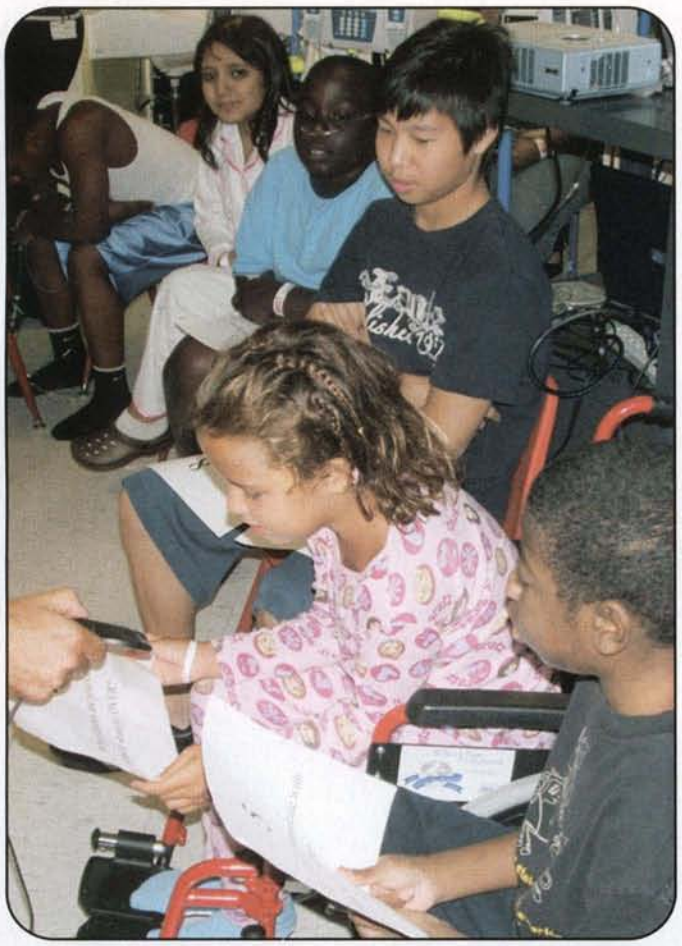

This child wanted to know what Anderson's duties are while he is on the ISS. (KF4HFC photo)

Because the ISS's orbital pass would occur over the western part of the United States, ground-station communication was provided by Santa Rosa Junior College amateur radio station W6SRJ in Santa Rosa, California. The station director is Tim Bosma, W6MU.

W6SRJ was linked to the hospital by using a phone patch, called a telebridge. At the hospital a conference phone was set up with microphones hanging from the ceiling and an additional hand microphone for more directional use during the actual contact. The audio for the event was carried over the IRLP Discovery Reflector 9010 and the Echolink AMSAT node, as is usually done for all ARISS contacts.

W6SRJ was operated by Bill Hillendahl, KH6GJV, and Don Dalby, KE6UAY. Will Marchant, KC6ROL, directed the Child Life staff in both the pre-contact preparation and post-contact wrap-up. Graham Lawton, G7EVY, was in charge of the audio for the IRLP connection. Child Life Specialist Linda Jones served as the hospital moderator for the event. The contact on board the ISS was with astronaut and flight engineer Clay Anderson, KD5PLA.

As the contact time drew closer, the 11 children were led into the setup area. Most were confined to wheelchairs and a vast array of health monitoring equipment was in use. As expected, all were very eager to get started. In order to help them relax before the contact, one of the Child Life personnel played a space trivia game with them.

After a few minutes Will Marchant, KC6ROL, began preparing the children and staff by introducing them to Bill and Don in Santa Rosa. Will explained the sequence of events that would take place during the contact, and very important, he allowed a few of the children to practice asking questions of Bill as though the contact were under way.

One of the most important aspects of any ARISS event is having the local media present. At the hospital's request, five broadcast news crews from four television stations, a radio station, and one newspaper had responded and were present to report on the QSO.

As the moment for AOS (acquisition of signal) from the ISS approached, at approximately 2:28 PM (EDT), Bill, the operator at W6SRJ, began calling Clay:"NA1SS, NA1SS, this is W6SRJ, over." After several attempts, a voice emerged from the noise and answered, "...NA1SS, over." Clay's voice was immediately greeted by an eruption of applause. Thus began a lively 9-minute question-and-answer session between the eager children and Anderson.

At Bill's direction, one by one the children began asking their prepared questions. The question-and-answer session with Clay continued very smoothly and at such a pace that soon all the prepared questions had been asked. With several minutes left in the pass, the children were asked to think up more questions for Clay. Some of these were quite thought provoking, such as one child asking, "What do you do if a solar flare occurs?" Just prior to LOS (loss of signal), a loud "Thank You" was sent up to Clay from the group and the contact was terminated. By the end of the pass, the children had asked 33 questions, possibly setting a record for any ARISS contact.

After the QSO it was the media's turn. They began interviewing the children, asking them questions such as, "Did they want to become astronauts?" and "What was it like to talk to one?" All of this media attention that the children received added greatly to the excitement of the day.

Final Notes and a Challenge

Unfortunately, for John Rothert, KC4IYO, leukemia proved to be fatal. At the time of the ARISS QSO, John was too ill to attend and he passed away within days of the contact. John's loss of his life at this time made the QSO all the more important, because among John's many accomplishments in amateur radio, this contact was his last major contribution to the hobby that he loved so very much.

Commenting on the day's activities in the hospital's internal newsletter "In Touch," Sheri Mosely, Child Life manager for Arnold Palmer Hospital, stated, "We're very excited about ARISS bringing its program to our patients, as it will be a fun activity that will lift their spirits. Talking with an astronaut is definitely a once-in-a-lifetime opportunity and one we hope they'll never forget." For all the participants, the students, and the staff, as well as the amateur radio operators who made it happen, all agree that truly, it was an ARISS QSO that will always be remembered.

A boy takes his turn asking Clay his prepared question. (KF4HFC photo)

The local press was out in force for this ARISS contact. (AA4KN photo)

Arnold Palmer Hospital for Children, which is supported by the Arnold Palmer Medical Center Foundation, is a 158-bed facility dedicated exclusively to the needs of children. Located in Orlando, Florida, the hospital includes comprehensive, specialized programs and services for children, including acute care, adolescent medicine, a Congenital Heart Institute in partnership with Miami Children's Hospital, pediatric intensive care, emergency medicine, nephrology, and neurology, along with emergency room and trauma services. It is one of four hospitals in the United States that are dedicated to the extensive care of children. It provides safety programs to children in three counties. More details about the hospital can be found on the following website: <http://www.orlandoregional.org/arnoldpalmerhospital/index.aspx>.

I have had the privilege of witnessing and helping in both SAREX and ARISS

Another girl takes her turn asking Clay her question. (KF4HFC photo)

The boy in the dark shirt asks Clay the spontaneous question, "What do you do if a solar flare occurs?" (AA4KN photo)

school contacts in the past, but none has been as moving as this event at the Arnold Palmer Hospital for Children. After witnessing the QSO, I requested a meeting with the Child Life department at All Children's Hospital in Tampa, Florida to discuss applying for an ARISS contact at their facility. As of this writing, my efforts to make contact with them have resulted in a positive interest in the possibility of their being a possible venue for a future ARISS QSO.

After reading this account of the first hospital ARISS QSO, you might have been challenged to replicate it at your local hospital. It is my opinion that by using a telebridge configuration, any facility should be able to accommodate an ARISS contact. Therefore, I encourage readers of this article, either as an individual or as a member of a club, to pursue such a possibility by making an appointment with the director of the Child Life or children's activity department at a children's hospital in your community, or in a near-by community. Use this article as a springboard for discussing the ARISS program with them and the impact that having a personal contact with an astronaut can have on their children. Then, request that they consider allowing you to apply for an ARISS contact at their facility.

As amateur radio operators, we have this unique opportunity to make a difference in children's lives as was done at Arnold Palmer Hospital for Children. Let's take advantage of this opportunity!

The Lost Letters of KH6UK

Part 3: The Klystron Years (1960–1961)

In part 1 of this series WA2VVA discussed how he came across the lost letters of Tommy Thomas, KH6UK, along with Tommy's tropo QSO with W6NLZ. In part 2 he discussed Tommy's pioneering VHF EME activities. Here WA2VVA presents the effect that the Klystron had on Tommy's EME activities.

By Mark Morrison,* WA2VVA

After three months of vacation, Tommy Thompson, KH6UK, and Helyne were back in Kahuku by February of 1960. Tommy's first job was to prepare for 432 Mc tropo tests with John and the other West Coast hams. In prior years, Tommy would have already been prepared for the next inversion season, but his long-deserved vacation took priority. Tommy had this to say:

> The 4 long johns are sitting in the yard waiting for phasing lines and matching xfrmrs. Shouldn't take long once I get the bridge. The 432 gang is all set up and we should be ready to start tests with NLZ in a week or two now.

It was about this time when Walt Morrison, W2CXY, was well on his way to building the first 1296 Klystron moonbounce station in the state of New Jersey, and one of only three anywhere in the world (the other two being W6HB in California and W1FZJ in Massachusetts). In January of 1960, Eimac shipped Walt the 3K2500LX Klystron shown in photos A and B. This historic tube and original shipping crate are now part of the Infoage Technology Museum in Wall, New Jersey.

Walt's interest in 1296 Mc made Tommy think about the band, even though his hands were already full on 144 and 432 Mc:

> The reason I mentioned 1296 Mc to Carl (W2AZL) was that I know just what will happen when and if John and I are lucky enough to get across on 432 Mc—that guy NLZ won't let one rest until we try it on 1296 too!

Apparently, Tommy was doing more than thinking about the band, because he later wrote that a dish was coming his way. It might be possible that Tommy's visit to Washington, DC the year before had opened the door to some surplus dishes. Walt received the 15-foot dish shown in photo C from the US Air Force, and it is believed to have been manufactured by the General Bronze Corporation of Long Island, New York. Tommy's dish was probably surplus equipment from somewhere on the island. Considering this was only 1960, both dishes probably had seen radar or early satellite tracking duty.

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Photo A. The Eimac KW Klystron delivered to W2CXY in 1960.

Regarding the dish. Latest word is that a 28 footer is on its way and should arrive some time in March. It is just a Kennedy dish—no dipole, no mntg. Don't know just what I will do with it yet as it has no particular advantage over the Yagi array.

Although Tommy showed an interest in 1296, he wasn't thinking moonbounce at this time. Rather, he was more interested in 1296 for continued trans-pacific work with John Chambers, W6NLZ.

> Apparently the boys back there are serious about doing the m/b [moonbounce] job on 1296. More power to them. They will need it. I think it is going to take some doing even on 144 Mc. Maybe the extra antenna gain on 1296 will do the trick; time will tell.

Photo B. The Eimac 3K2500LX Klystron used for early moonbounce work.

Photo C. The 15-foot parabolic dish of W2CXY, Chatham, New Jersey, circa 1960.

As Walt was busy putting his Klystron power supplies together, he apparently contemplated one more shot at 2-meter moonbounce. Tommy commented on this in one of his letters:

I see you are now talking 42 foot Yagis with 2 1/2 inch and 2 inch phase shift. Boy, that is going to be a big hunk of stuff to get up in the air—and keep up! Think I would settle for four 36 footers. As I recall Ross [Bateman] had to go to stacked rhombics before he got any results worthwhile. I agree entirely with Ross—every step has to be checked and double checked to make sure you are actually getting the gain, etc., you are suppose to. The tape of Ross's moonbounce signal was very interesting and should be able to be duplicated by a couple of serious guys. I wonder just how much gain was picked up by ground reflection. Evidently some as Ross claimed signal was best with ant aimed about 2° above the horizon. Has anyone heard their own echo overhead?

One important piece of equipment was still missing from Tommy's shack, and that was a stable receiver. This is what Tommy had to say:

Carl [W2AZL] had a good idea and even suggested he might supply us both with a highly reliable freq. standard for 144.000.000 kc. That unit he was working on plus a harm. gen. of some kind would be a nice thing to have. We must have exceptionable freq. stability—both xmtr and rcvr—even with line voltage excursions caused by transmitter load with on/off keying. The osc. Carl is working on is not affected by supply voltage variations so should be the nuts for the xmtr. Your Collins receiver may be ok in this respect too —I dunno. While my SX88 has xtal conversion oscillators it does have some shift when xmtr is keyed. I will check into this and remedy. You might check yr end too.

Tommy later expressed interest in a Racal receiver based on testing that Carl had done, most likely at the Bell Telephone Laboratories in New Jersey, where he worked.

I still haven't ordered the Racal. For awhile it looked like was gg to get an R-390 which is a vy fb Collins job but that fell thru. Still trying and if nd will have to go back to serious consideration of the Racal. Should decide one way or another in the next week or so.

By April of 1960 Tommy was still uncertain about antenna plans. He lamented not having time for 144 Mc, 432 Mc, and 1296 Mc simultaneously and remained skeptical about 1296 moonbounce for the time being. Perhaps his enthusiasm had been dampened by some insider information. In a letter to Walt, W2CXY, he wrote:

I am not as optimistic as you re 1296 m/b. For your information there is high power activity on the West Coast on 1296 Mc—and for that matter even here in KH6 land. The Eimac gang is working on it with Sam, W1FZJ, and there is a W7-W6 setting up for tests with a couple of lads in the Air Force out here. Keeping it all vy quiet so no one should beat them to the punch. For my part I would like to try it on 144 Mc first. After hearing Ross's tape and knowing we can do several decibel better job all around it goes without saying that we could make the grade with the proper installations—which are within easy reach—except for antennas. For me anyhow, 1296 is an entirely different

proposition. I have nil for this band and it will take a first class setup to do the job.

In a subsequent letter, Tommy mentioned something interesting about his antenna: "The only bad feature is being limited to only a couple of nights a month. This I don't care for."

This suggests, once again, that Tommy's 2-meter array could not track the moon. It could also explain his interest in stacked rhombics, something he seriously considered after a visit to the island by veteran moonbouncer Ross Bateman, W4AO. In 1953 Ross had used stacked rhombics to bounce the first amateur echoes off the moon. Tommy thought that such an antenna, along with a KW amplifier and parametric amplifier "al la W6AJF," might just do the job.

As Tommy contemplated the possibility of stacked rhombics, something for which he had plenty of room, he also considered a relatively obscure form of DX propagation—namely, transequatorial scatter:

I would like to investigate the possibility of using 144 Mc when 50 Mc is open to LW3EX on TE_S. I have the feeling this might pay off. He is also working with some of the others down there using tropo scatter. PY3AB also is interested—so he writes me—and I sent him some dope. If I am going to do that kind of work tho I'll need a rotary beam. Maybe the answer is to use the dish on 432 and later on 1296 and bld big array for 144 Mc which I can rotate.

That last sentence seems to confirm that Tommy's beam was not suited for tracking the moon. At this point in time, his moonbounce partner, Walt, was focusing on his 1296 Klystron station about which Tommy commented:

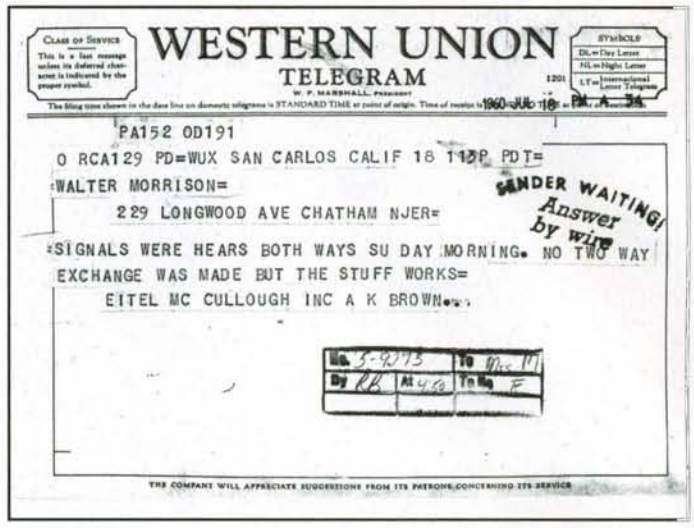
I doubt you are gg to hv much time available for 144 m/b now if you are setting up for 1296. By the way, VWU now on job that include purchase of a 32 foot dish—which he is supposed to be able to use when it is not in operation.

In a statement reminiscent of the 1928 Presidential campaign, Tommy added "The ways things are gg, we'll have a dish in every garage!" In light of all the satellite TV dishes across the country, Tommy's prediction wasn't far off.

Tommy mentioned to Walt that Carl Scheideler, W2AZL, was just about finished with the frequency standards. He also mentioned again that if he and John, W6NLZ, were lucky enough to get across the Pacific on 432 Mc "then I am sure there will be a mad rush to get on 1296 Mc." Tommy commented, "the whole VHF gang seems to have dropped away and found other interest … wonder where W8PT is, also what is Paul, W4HHK, and W9WOK doing these days? Guess we will have to stir them up again." This last phrase is one that Tommy repeated quite often in his letters. Tommy was always interested in making the most of the amateur bands and keeping others interested as well.

By the summer of 1960 the race was heating up to complete the first moonbounce QSO. As Tommy had mentioned, several groups were already working on it, including his friend Walt. In the end, it came down to two groups, the Eimac group in California and the Sam Harris group in Massachusetts. Apparently, Walt had some inside information, too, since he predicted to Tommy that this latter partnership would be successful. Tommy had this to say:

I see your prediction of things to come only missed by a couple of months … with the QSO on 1296 Mc m/b taking place between W1BU/W6HB on 21 July. Sorry to hear that W2CXY wasn't one of the participants … but evidently this was a joint project with several hands taking part on both ends. In any event it was a real accomplishment and the boys deserve a lot of credit.



WESTERN UNION
TELEGRAM

PA152 OD191
O RCA129 PD=WUX SAN CARLOS CALIF 16 1135P PDT=
WALTER MORRISON=
229 LONGWOOD AVE CHATHAM NJER=
SIGNALS WERE HEARS BOTH WAYS SU DAY MORNING. NO TWO WAY
EXCHANGE WAS MADE BUT THE STUFF WORKS=
EITEL MC CULLOUGH INC A K BROWN

SENDER WAITING! Answer by wire

Figure 1. Western Union Telegram from Hank Brown, W6HB, to Walt Morrison, W2CXY.

The Western Union telegram shown in figure 1 and received by Walt from Hank Brown, W6HB, on July 18th of 1960, just three days before that first successful moonbounce QSO, shows the level of trust that existed between Walt and Eimac. Although intended to be a secret, Hank kept Walt in the loop.

Hank later wrote these words in a *QST* magazine about the role of Walt Morrison in that first successful moonbounce QSO:

The project received a trmendous boost when Walt Morrison, W2CXY, contacted Hank and told him of East Coast interest in the undertaking. Accordingly, several Eimac u.h.f. transmitting klystrons were modified to reach a frequency of 1296 Mc and one was shipped to Walt, and another to Sam Harris, W1FZJ.

Tommy commented, "now that the ice is broken no doubt there will be a lot of activity on that band [1296] … and worldwide DX only a question of time." He added that as soon as the 432 activity was done for the year, both he and John should join Walt and the others for a KH6/East Coast QSO, something that he and Walt had always dreamed about. Since Walt had already begun work on his 1296 station a year earlier, Tommy requested information on the Klystron power supplies. He commented:

John and I are planning to test over the usual path here even though it will not involve setting a new record [for 1296 Mc]. I would greatly appreciate any info you might have with regards to power supplies, etc., for the Klystron. Walt, this will be an entirely new field for me and I will need lots of help. Guess any plans for 144 Mc m/b will have to wait as I guess neither of us have the time to spend on that band and do a good job on 1296 too.

One of the biggest problems Tommy faced on the islands was a lack of other signals to tune in to. Thus, if a problem existed on the receiving end he might not have known about it until much later.

With no signals of any kind to test with out here I had no way of telling if equipment was working OK or not or to check its operation from time to time as is possible when you are using the band from day to day.

In July of 1960 this proved to be a problem when Tommy's 432 Mc signal could be heard by John but not the other way around.

I suppose you have heard by now of our partial success on 432 Mc. Failure of the receiving setup here was the only thing that prevented it from being two-way ... so we had to be satisfied with making it a cross-band QSO ... which is little satisfaction. We had been running tests since 15 March without a sign of a signal of any kind, when on 20 July John called me frantically at 0510Z to tell me I was in 579 ... I listened but heard nil ... signal QSB in and out for the next several hours, and while I overhauled just about everything in the receiving installation I could not hear John's signals. Too late I found that a brand new Dow antenna relay was hanging up in the transmit position and also that feed through was paralysing my parametric amplifier diode which took several hours to recover.

Tommy reported how he was now prepared for future band openings: "Oh, well, wait until next time ... if we do get a next time. I now have two complete receiving setups and can check their operation to some degree at least." Tommy then lamented how the VHF world was changing, as the gang wasn't showing up on the old frequency anymore.

How is Pappy [Carl Scheideler, W2AZL] ... and what is he doing these days ...never hear you guys on 14095 any more so have lost touch. Also no Art, W8KAY. In fact no one ever shows up on the old frequency anymore, so don't know what is going on with the gang.

In that same letter, Tommy mentioned a lunch meeting with Hank Brown, W6HB, the ham generally credited with the success of the first amateur moonbounce QSO: "Will QRT now as just have time to get to Honolulu where we are going to have lunch with Hank Brown and his wife who are vacationing here on the islands." This meeting was highly significant, as Hank was the person to know if you needed a 1296 Klystron at the time. In 1960 only three such Klystrons existed. One was used by Hank Brown,W6HB (HB—Hank Brown), another by Walt Morrison, W2CXY, and the third by Sam Harris, W1FZJ/W1BU. This lunch meeting was more than just pleasure as we shall see shortly. There is no doubt that Tommy's DX location would guarantee him a spot in the record books if only he could work an East Coast station on 1296 Mc.

Photo D. The Eimac Klystron amplifier (right) and the rack-mounted magnetic power supplies built by Walt (left) prior to being relocated to Infoage in Wall, New Jersey.

By October of 1960 Tommy had just about given up on 432 tests with John and Frank for the season. Tommy reported, "It had been a rather poor year for inversions due to an exceptionally windy Summer ... except for the one day we got across in July...we never did really hit favorable conditions." Tommy indicated they would wait until 1961 to pick up where they left off and probably use the 432 Mc driver with a 1296 tripler to drive the Klystron. Tommy added, "Then when and if we hit favorable conditions on one band we can shift quickly to the other and kill two birds with one stone." By this time Hank Brown had arranged for Tommy to receive a Klystron, which would arrive in a few months.

Even as 1296 progress was being made, Tommy continued to express interest in 144 Mc moonbounce tests with Walt if he remained in Kahuku for another three years as this letter shows:

Regarding 144 Mc plans, Walter, if I stay over here longer than next year I would be interested in doing something on m/b on this band and put up stacked rhombics for this purpose. My second 3 year hitch ends next November and probably be busy with 1296 Mc operation during the remainder of this time so any work on 144 Mc will depend on what develops in the future.

Tommy talks about another milestone in VHF radio, that of Ed Tilton retiring as Editor of "The World Above 50Mc" after some 20 years. In December 1939, Tilton inaugurated the first *QST* column devoted to VHF. Originally called "On

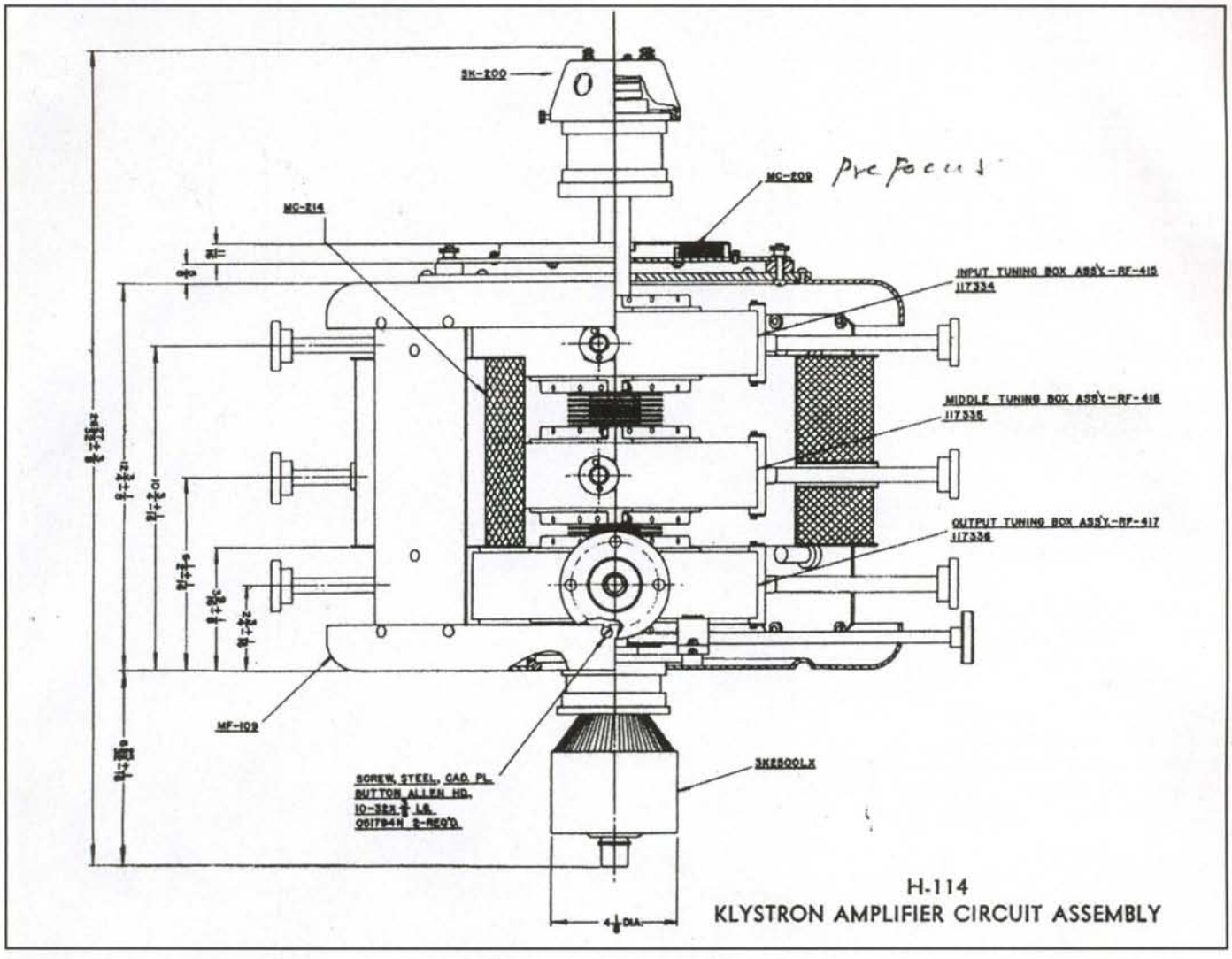


Figure 2. Close-up view of the Klystron amplifier circuitry assembly, from Eimac.

the Ultra Highs," it eventually became "The World Above 50 MHz."

Tilton edited the VHF column until he retired from the ARRL staff in 1960, reporting on-the-air activity and encouraging experimentation initially on the then 56 and 112 MHz amateur allocations, and later on all VHF and UHF bands. The UHF DX Records box—the precursor of today's standings boxes—debuted in 1940. He was the author of the ARRL's first *VHF Manual* and wrote numerous articles for *QST*. Along the way Tilton had witnessed every new development in amateur VHF communications. Here's what Tommy had to say about Tilton and Sam Harris, W1FZJ, who succeeded Ed by moving over from *CQ* magazine to *QST*:

Looks like old Ed Tilton has finally given up the VHF column in *QST*. In some ways I am sorry to see him go and it will seem strange to read Sam's stuff there instead of in *CQ* ... I am in rather a peculiar position now as I never did send any info to *CQ* but only to *QST* so don't know how it will be now with Sam there and Bob [Bob Brown, K2ZSQ] at *CQ*."

In January of 1961 Tommy reported that ham radio "had to take a back seat" due to the workload at RCAC and the birth of the nation's space program:

We added several military circuits and are also providing some of the facilities for the Mercury Project so had deadlines to meet as well as a lot of extra work ... all with a small staff.

Tommy gave Walt more information on his 1296 setup as follows:

How are you doing on 1296 Mc? I suppose you have your dish up on a polar mount and lots of watts into it from the Klystron. It's a good thing you have a lot of room in your basement as I understand those Klystrons are quite a size not to mention the power supplies for them. My Klystron has been shipped and should be here is a week or two now ... John received his the other day [bringing the total now to five] and is very much concerned about not being able to keep the input down to a kilowatt. He feels the deal is getting too xxxx commercial and wonders if it is worth the trouble ... maybe he is right, hi. My dish still lays on the ground where it has been for the past few months ... just no time to work on it as I said before. But I am going to mount it on something soon now come xxxx or high water. I am building the low power tripler stagers for 1296 Mc drive and AJF is building the Para Amp and Converter for this frequency for me. I have been thinking I might put the equipment in a small shack out back so it will be at the antenna ... I am running out of room in the living room, hi. Wonder if you could find time to send me some dope on the Klystron installation, Walt. I have had no experience with the beast and will have to start from scratch ... so will have to fall back on my old friends for help as in the past.

By this time Walt had completed his power supplies in rack-and-cabinet fashion. Photo D shows the Eimac Klystron amplifier (right) and the rack-mounted magnetic power supplies built by Walt (left) prior to being relocated to Infoage in Wall, New Jersey.

The diagram from Eimac (figure 2) shows a close-up view of the Klystron amplifier circuit, which consisted of separate tuning boxes and associated focusing coils.

Tommy apparently consulted with Walt on power supplies and added the following:

> Once I get squared away on 1296 Mc I will be ready to work you via m/b, Walt. How are you coming along ... have you heard your own echoes or worked anyone yet? I see there is supposed to be quite a gang working on these frequencies according to *QST* and *CQ* mags. I would be interested to hear what the East Coast boys are actually doing, so how about a report OB ... my best to the gang and the XYL. Has Carl switched to 1296 Mc yet?

Shortly after that letter was written, the General Electric Company held a special awards dinner for both Tommy and John at which they received the coveted Edison Award for their pioneering work in trans-pacific VHF communications (photo E). Both hams were flown to Washington, DC aboard commercial jet airliners. It is interesting to note that jet service had only started the year before, so this must have been a real thrill.

In a letter from March of 1961, Tommy thanked Walt for congratulating him on the Edison Award and described the scene this way:

> It was an unexpected surprise as it has always been awarded for other types of work, as you know. Really had a wonderful trip both ways on jets and the GE boys took real good care of us while we were there.

Tommy reported that work at RCAC had started to "ease up" and "present plans call for continuing 432 Mc tests with John until we make it a two-way and in the meantime we are getting set up on 1296 Mc." The plan was to use 432 equipment to establish contact on that band and then switch in a tripler to multiply 432 to 1296. In this manner Tommy and John could easily switch back and forth until contact was also established on 1296. Unfortunately, the work at RCAC had delayed things to the point where Tommy didn't think he'd be ready in time for the next inversion season. Tommy mentioned that Frank Jones, W6AJF, had his para amp and crystal-controlled converter about ready and Tommy had the 1296 exciter working at a few watts but not yet connected to the Klystron. Tommy received a mount for his dish and attached it to his garage. Not quite sure if it could handle the big dish due to the winds of Kahuku, he decided to add guy wires to keep it stabilized.

As with most of the Klystron moonbouncers, Tommy had concerns about the high-voltage power supply. Somewhere around 7 kV at 455 mA was required and locating a suitable transformer had proven most difficult. Shown in figure 3 is an excerpt from the Eimac 3K2500LX data sheet. Although the spec sheet implies a mere 2 watts of input drive could translate to 1300 watts output power, most moonbouncers ran this tube at around 300 watts.

An even bigger challenge was the transmit/receive relay. No commercial equipment existed for this purpose and even the first moonbounce QSO between W1BU and W6HB involved a manual operation using crescent wrenches to switch the antenna between the transmit and receive positions.

In the months following the breakthrough QSO between

Photo E. John T. Chambers, W6NLZ (center), and Ralph Thomas, KH6UK (right), receive Edison Award trophies from General Electric Vice President L. Berkley Davis at a Washington ceremony, February 23, 1961. The award was in recognition of the trans-pacific communication by these outstanding amateurs on 144, 200, and 432 Mc. (From the ARRL VHF Manual, *1972)*

W1BU and W6HB, Walt took one more look at 144 Mc moonbounce. One reason might have been that 1296 had already been conquered. Another could be the amount of effort, planning, and manpower required for serious 1296 operations. Both sides of the first moonbounce QSO in 1960 involved teams of people, each with certain responsibilities. Yet another reason could be the concern that 1296 operations had become too commercial, something echoed in letters from both Tommy and John. On 144 Mc you built your own beams, experimented with element spacing, built your own converters, and worked in much smaller groups, sometimes solo. 1296 operations were different, with major portions of the station being commercial items that were either purchased or loaned, save possibly the paramp and crystal-controlled converter, and teams of people at both ends. This is what Tommy and John had to say about future 2-meter operations. Tommy wrote:

> I have no plans of any 144 Mc operation at this time, Walt, as will have my hands full with 1296 Mc for awhile. If the power restriction is ever removed from 432 Mc then I would be interested in m/b on that band. John and I spent a great deal of time while we were in Wn on this subject .... Time will tell. In the meantime mum is the word so forget I mentioned it, Walt. If I ever was going to try 144 Mc moonbounce I would put up stacked rhombics for it, Walt, as would only be interested in working you fellows back east.

In a "lost letter of W6NLZ," John Chambers wrote:

> Am about 2 weeks from turning on Klystron, sure xxxx of a lot of work, driver works fine, good 20W out. RX seems ok and paramp makes it better. But I don't know how much better. Will run RG17/U for coax, let it get warm. Still no big dish but possible deal on 17 footer. No DX activity on 144 Mc at all, haven't had 2 meters, been on with beam for almost two years. I can't see anything interesting to do on 144 Mc, takes too big antenna for m/b. If we can get rid of power limit on 432 that sounds like fine band. Also working on crystal controlled gear for 2350 Mc.

TYPICAL OPERATION

NARROW-BAND CW AMPLIFIER (In H-114 Circuit Assembly)

Frequency	—	—	—	—	—	—	1000	1000	megacycles
Output Power	—	—	—	—	—	—	830	1320	watts
Driving Power	—	—	—	—	—	—	2	2	watts
Power Gain	—	—	—	—	—	—	26.1	28.2	db
D-C Beam Voltage	—	—	—	—	—	—	6000	7000	volts
D-C Beam Current	—	—	—	—	—	—	350	455	milliamperes
Beam Input Power	—	—	—	—	—	—	2100	3180	watts
Beam Power Efficiency	—	—	—	—	—	—	39.5	41.4	percent
D-C Body Current	—	—	—	—	—	—	40	30	milliamperes
D-C Collector Current	—	—	—	—	—	—	310	425	milliamperes
Collector Dissipation*	—	—	—	—	—	—	1030	1650	watts
Focus-Electrode Voltage	—	—	—	—	—	—	–100	–100	volts
Heater Voltage	—	—	—	—	—	—	7.5	7.5	volts
Heater Current	—	—	—	—	—	—	5.8	5.8	amperes
Magnetic-Coil Currents*									
Prefocus	—	—	—	—	—	—	0.5	0.5	ampere
Body	—	—	—	—	—	—	2.0	2.0	amperes

*Approximate values.

Figure 3. Excerpt from the Eimac 3K2500LX data sheet. Note how an input of only 2 watts would provide an output of over 1300 watts!

Another concern in the summer of 1961 was the uncertainty of how long Tommy would remain in Hawaii. By the time his three-year hitch was up in 1963 he would looking to retire back in the United States.

I don't know how much longer we will stay in these parts so have no long range plans at this time. Have another vacation coming up this next November but might possibly wait until next Spring to come back. Maybe it will be for good and maybe for a few months vacation, don't know yet as we can't seem to be able to decide where we want to settle down when we do retire. Anyway we don't have to decide yet and there are a few more things I would like to accomplish before I pull out of here. I never will have another spot like this for UHF work, hi.

The lack of local signals to tune in to continued to be a problem for Tommy. Walt suggested a tube that could be used as a frequency standard for the 1296 Mc band and Tommy expressed great interest in it.

I like your idea about using your big tube for a standard for the 1296 Mc boys back east. Only wish I had some kind of a signal to check with from time to time … sure would be a big help out here where there is not activity of any kind. A guy has to be off his rocker to go to all the trouble and expense I do to listen to tube hiss month after month. I was interested to hear about your findings on tube line-up for converters … especially how good the nuvistors are turning out to be. I am down to my last 416B now so will have to find something to replace this type with soon.

In November of 1961 Walt received a letter from Hank Brown, W6HB, regarding possible schedules on 1296. The plan was to liaison on 14095 or 7095 using the station of W6SC and a different call (W6AY) on 1296 Mc. At this point all the Klystron-based stations still had a common problem, that of switching the antenna between the transmitter and the receiver. Here's what Hank had to say:

You mentioned your antenna switching problem. This is a real stinker and I still remember the frequent use of crescent wrenches during the schedules with Sam.

One week later Walt received a letter from John Chambers, W6NLZ, sharing information about the Klystron he had received from Eimac. Walt's early start on his 1296 station made him a source of useful information to others who followed. Johns commented:

Glad to hear about the 1296 progress. As you probably know, I have had the Klystron operating for several months, but only into an 8 foot dish. No DX of course, but S9+ signals 100 miles away and over the mountains—the terror of the locals. No results from attempted moon echoes. The paramp from *QST* last year appears to work fine. The master oscillator is a Collins 40K-1. Receiver band pass 3 Kc, 500 cycles, or 125 cycles, but tuning 75A3 receiver with a 125 pass band is rough.

John added something that appears in many of Tommy's letters—namely, the practice of writing letters and sharing information on other hams had served to keep interest levels high. Here's what John had to say in a letter to Hank Brown:

What's important is that your letters have me interested again. With UPX-4 [a type of surplus equipment] it appears as though there may be something to work besides locals and KH6UK. I cannot overstate the importance of liaison—preferably 7095 Kc. Tommy and I never would have made it without good liaison. Please keep me posted as this will help keep me moving. I will do the same though there are times when it seems more pleasant to just gab with the locals on 220 and 432. . .

By the end of 1961 it appears that five 1296 Klystrons had been delivered into amateurs' hands, largely due to the efforts of one man, Eimac's Hank Brown. In the months to follow, Hank would lead these "Klystron Pioneers" in a series of coordinated moonbounce tests, which is the subject of Part 4 of this series.

Are Tropo Extensions to Sporadic-E Openings Possible?

Many of us weak-signal operators occasionally have experienced a DX QSO that is beyond what we might expect for the single-hop sporadic-*E* propagation range. WB2AMU offers a possible explanation of how it was possible to complete such a QSO.

By Ken Neubeck,* WB2AMU

Sometimes veteran 6-meter operators wonder whether there are other forces at play that seem to extend an apparent sporadic-*E* opening beyond the normal single-hop distance. This question often comes to mind with regard to long-range paths when two-hop sporadic-*E* is part of the equation but still seems to need an additional mode to carry the signal.

In previous articles presented in *CQ VHF* and *CQ* magazines, discussions were presented about "mix and match" propagation, where different modes of propagation combine to carry a 6-meter signal over specific distances. For example, during the height of the latest sunspot peak, it was observed that *F2* paths combined with sporadic-*E* openings to extend distances, and sometimes past sunset. One mix-and-match mode that would seem possible, but hard to prove based strictly on radio observations, is the combination of tropospheric-ducting paths with sporadic-*E* skip.

In this article we will explore the possibility of this combination mode as well as examine the type of geometry that would be involved if a tropospheric-duct path was connected to the end of a sporadic-*E* path. The emphasis primary will be on 50-MHz events. However, a special case of a 144-MHz event will be discussed as well.

Geometry of a Sporadic-*E* and Tropo Path

One path that comes to mind is the path between the northeast US and the UK during the summer months. Conventional thinking states that this path is at least a two-hop sporadic-*E* opening, and sometimes a three-hop sporadic-*E* opening. However, another model that could fit is a two-hop sporadic-*E* opening with tropo extensions on one or both sides of the path of the contact. Figure 1 shows the geometry of such a potential combination.

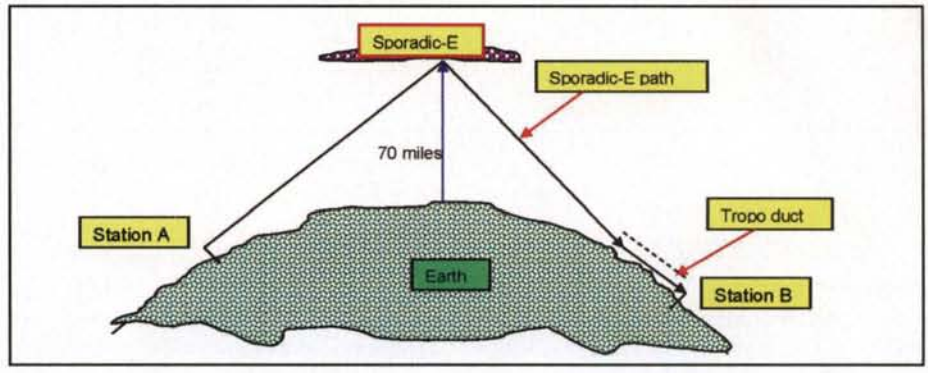


*Figure 1. Geometry of tropo extension to sporadic-*E *opening.*

With long-range contacts such as these, it is almost impossible to tell by listening to the signal quality whether there may be some tropo enhancement on one end of the path. If there was such an extension to the sporadic-*E* link, it would be just as hard to determine which side of the link the tropo extension was on. Sometimes tropo has a unique fading quality of the signal that differs from the rapid fading experienced with sporadic-*E*. However, if the two modes are combined, it basically would be impossible to tell which of the modes was causing the signal fading.

Indeed, it generally is impossible by just listening to the signals to tell for sure if there is such a combination. However, a map-plot approach may actually provide clues. For example, during the heat of the summertime sporadic-*E* season, stations in much of Florida can work stations in South America and a good portion of the Caribbean on 6 meters. However, there are some Caribbean stations that are difficult for Florida stations to work, because the distance falls beyond a single-hop sporadic-*E* opening and somewhat short for a double-hop sporadic-*E* opening. It is kind of like a one-and-a-half sporadic-*E* path, and would almost be like very short sporadic-*E* skips lined up back-to-back, which is pretty rare. If two very short skips on 6x meters actually happened, there probably would be a possibility of 2-meter sporadic-*E* at the same time.

The evidence, however, appears to point to a single-hop sporadic-*E* coupled with tropo enhancement on one or both ends of the path. A single-hop sporadic-*E* opening could cover about 1000 miles. Coupled with a tropo enhancement that covers an additional 200 to 400 miles, you actually could get the effect of a one-and-a-half sporadic-*E* path!

In some parts of the world, such as the New Zealand and Australia area, natural weather conditions exist in which long-range tropo paths can occur on all of the VHF bands from 6 meters and up, particularly during the summer. It would not be unreasonable to suspect that some of these paths could actually link up with sporadic-*E* openings to provide paths between areas that normally would not be

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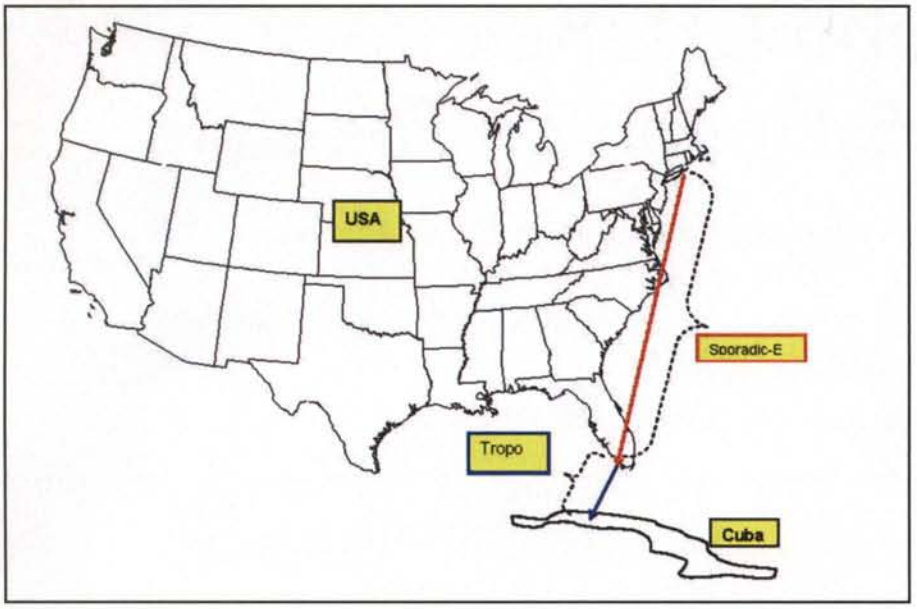

*Figure 2. Potential 50-MHz path involving sporadic-*E *skip with tropo link, Long island, NY to Cuba.*

covered by a single-hop or even double-hop sporadic-*E* link. With more observations made by radio amateurs in this area of the world, it will be possible to identify such events.

It would be reasonable to assume that such tropo-extensions would be more likely to occur over water paths and coastal areas around land masses, where ducting can occur from spring to the early fall.

Case Study #1
50-MHz Sporadic-E plus Tropo into Cuba

Over the 15 years that I have observed sporadic-*E* on 6 meters, one of the paths I have noted is from my location on Long Island, New York towards the south, into the state of Florida. It is not uncommon for me to be able to work into southern Florida several times during each summer season by single-hop sporadic-*E*.

What I have found a bit less common over the years, though, is my ability to work Cuba on a regular basis during the summer months. There typically are three to five active stations in Cuba, such as CO2KK, CO2OJ, CO8DM, and CO8LY. In reviewing past observations in working these stations, I found that typically signals were at best moderately strong, and I usually worked them during the late afternoon into the evening hours. Both of these facts may be relevant, because a combination sporadic-*E*/tropo event might not necessarily have the best signal strength, and the later hours of the day are generally more conducive to tropo paths (just like early morning, as well). Again, these observations do not represent conclusive results, but are just some suspicions that a combination mode of the two phenomena may be at work.

The plotting of such a potential path is shown in figure 2. For this particular example, I assumed a normal 6-meter sporadic-*E* path reaching southern Florida and covering a distance of 1300 miles. I then went with the great possibility of a tropo path being present from southern Florida over the waters into Cuba to cover the additional 200 to 300 miles or so. While tropo paths are possible at my end on 6 meters (where they can extend into southern New Jersey), I looked at the case where the path was on the southern end because of the higher likelihood of tropo activity farther south than southern Florida.

One of the problems regarding tropo paths in general is they often may be subjected to high amounts of fading, particularly on bands such as 6 meters. Having participated in the recent ARRL 10 Meter Contest during which there was not a lot of skip activity but a moderate amount of tropo paths, signals were moderately strong for five to ten seconds at a time before fading. Indeed, I generally have found that when tropo ducts occurred in the past, the higher VHF bands such as 144 and 432 MHz seem to have better signal quality compared to 6 meters.

Case Study #2
50-MHz Sporadic-*E* plus Tropo into Hawaii

Inherently, one would suspect that tropo paths in certain areas are more stable in terms of duration and signal quality than in other areas. For example, during the summer the tropo path from southern California into Hawaii on the higher VHF bands is very stable and can have both long-duration and strong signals associated with it. It is not inconceivable that such a path on 6 meters could link up with a sporadic-*E* opening from the Midwest (figure 3). Certainly, the smaller wavelength VHF bands such as 144 and 432 MHz are more favorable for this duct, but 6 meters experiences it occasionally as well.

I visited southern California in May of 1992, and at that time the locals reported such an opening into Hawaii on 6 meters. It is possible that if there was a sporadic-*E* opening occurring on 6 meters into southern California at the same time from Midwest stations, that stations from the Midwest could work into Hawaii!

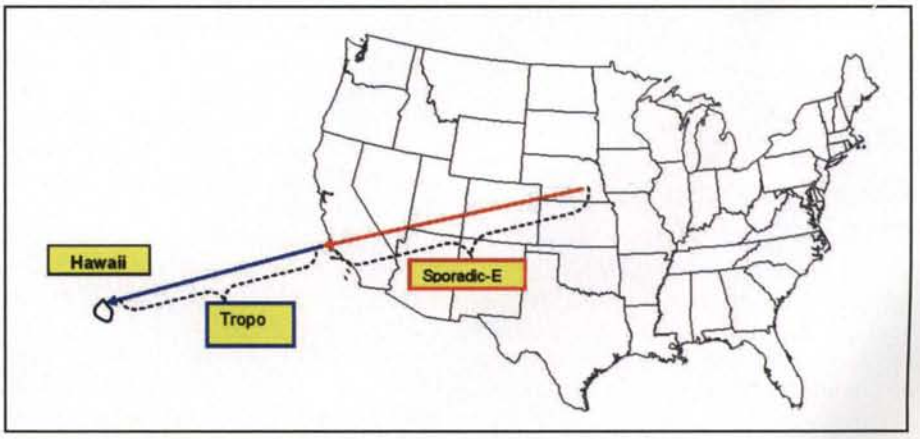

*Figure 3. Potential 50-MHz path involving sporadic-*E *skip with tropo link, the Midwest to Hawaii.*

I had further discussions about this tropo path occurring on 6 meters with Gordon West, WB6NOA, who has frequently observed this path from the southern California area on 144 MHz and higher. One of the problems Gordon pointed out is the fact that there is not a 6-meter beacon on Hawaii; there are 144- and 432-MHz beacons that are spotted by California hams when this path occurs. Gordon also noted (and there is information on the internet) that FM broadcasts are heard on both ends of the path, so with the FM band beginning at 88 MHz, it would not be unreasonable to assume that 6-meter signals are likely as well.

One wonders whether a sporadic-*E* opening could tie into this link during those very rare 6-meter openings into Hawaii from the northeast US during the summer months. The probability of triple- and quadruple-hop sporadic-*E* becomes less likely, but not impossible, for a path between the Northeast and Hawaii. The tropo path (which already covers over 2000 miles) linked to single-hop and double-hop sporadic-*E* would be a more likely scenario. It would be interesting to see what 6-meter contacts into Hawaii have been made over the years during the summer from both the Midwest and the Northeast.

Case Study #3

144-MHz Sporadic-*E* plus Tropo link in Europe

This is a case study involving a possible tropo link with a 2-meter sporadic-*E* opening that occurred in Europe in May 2003 as reported by Volker Grassmann, DF5AI, and Udo Langenohl, DK5YA, in the article "Very Long Distance Propagation in the 144 MHz Band" (go to: <http://www.df5ai.net/ArticlesDL/VLDP_EA8.pdf>.

This article points out a case in which a tropo path from the Canary Islands into the Portugal/Spain area occurred at the same time as a sporadic-*E* opening between Portugal/Spain and central Europe on 144 MHz on May 20, 2003. The article states that the Canary Island path into the Iberian Peninsula is an occasional tropo path that occurs over the Atlantic Ocean during the summer months, and on this particular date it linked up with what appeared to be a sporadic-*E* opening. Apparently, it allowed many 144-MHz QSOs into central Europe. Please review this excellent article for the various maps and plots that were recorded. This particular event was very well plotted because of the large number of European stations that caught the opening.

It would be very rare, but not impossible, for this type of combination (sporadic-*E* plus tropo) to occur on 144 MHz in the US. This is because 144-MHz sporadic-*E* events are very rare here in the US. They may appear once or twice in a summer season during intense periods of ionization of sporadic-*E* formations in the *E*-layer. Such an event was captured in Europe because 144-MHz sporadic-*E* appears to occur there a few more times during the summer season than in the US, and because of the large number of active hams on 144 MHz in Europe. One can argue whether there are more active hams on 144 MHz in Europe than in the US, but regular monitoring of the 144.200-MHz frequency in the US shows a significant lack of activity, making it harder to capture a sporadic-*E* event.

Based on previous articles and reports, an area of the world that sees moderate levels of 144-MHz sporadic-*E* activity is Japan. Since Japan is surrounded by water, there most likely also would be some tropo paths that exist that could link to sporadic-*E*. The problem becomes the great lack of VHF activity in the countries that surround Japan. At best, an SWL on the FM broadcast band could provide some information in this regard.

The same is true for the New Zealand/Australia area. Hams have recorded many long-distance contacts on 6 meters, 144 MHz, and 432 MHz where tropo seems to be the primary mode and sporadic-*E* events could be at play on occasion for the lower VHF frequencies.

Summary

Why is this phenomenon so important to understand? While the occurrence of tropo ducting is one of the easier VHF modes to predict, it also has its nuances, as described in this article. It would seem likely that it must be in play when certain paths occur on 6 meters, and as described in the last case study, on rare occasions on 2 meters. Again, increased activity on the VHF bands would help capture more of these events when they happen. A key component of this is the use of internet spotting and alerts.

I will continue to revisit this subject in the future with the hope of gaining additional observations, and I welcome hearing from VHF operators in different parts of the US and the world with regard to their observations.

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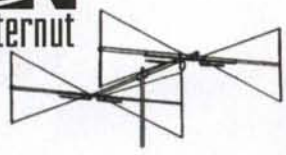

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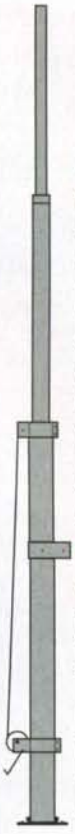

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Non-Noodling Rover Masts

Whether it's via rover operation or supplying emergency communications, the portable station operator often finds it difficult to reliably erect an antenna up more than about 15 feet. Here WB6NOA reviews the BlueSky Lite mast for its ability to fill the height needs of rover operators as well as portable emergency communicators.

By Gordon West,* WB6NOA

Ham radio operators know all too well the word "noodle"—*the unpredictable, unsteady bowing* of light-weight mast sections. As VHF and UHF rover operators are aware, getting your antennas higher than the local scrub likely requires non-noodling, stout mast sections capable of supporting even a rotor on top.

"We had our long boomers up and playing at 40 feet with absolutely no noodling," comments Bill Alber, WA6CAX, referring to the BlueSky Lite mast system (http://www.BlueSkyLite.com) available from W4RT Electronics (http://www.W4RT.com). Barry Johnson, W4WB, of W4RT Electronics, was so impressed with these made-in-the-USA mast systems from BlueLite that he brought them in for distribution at W4RT.

The blue anodized-aluminum mast systems are manufactured in Florida, originally intended for the public-safety market after a hurricane or tornado has ripped through town. The quickly deployable system is "ready to roll," in a professional-looking 54" × 14" × 14" three-wheel carry bag with fiberglass runners to slide easily into a pickup truck. During a recent Field Day, preceded by the ARRL June VHF QSO Party, we deployed the mast system to support everything from a Hi-Q motorized dipole system; followed by a pair of stacked boomers, including rotator; and finally tested with a Hex beam covering 6 through 20 meters.

For one test, during the VHF QSO Party, we compared mast rigidity of two 30-foot mast systems, supporting Chip, K7JA's homebrew copper-water-pipe 6-meter beam. With conventional mast materials, numerous sections of guy rope were required to keep Chip's beam steady. With the BlueSky Lite 30-foot mast kit, only a single set of (supplied) guy ropes to the included guy ring was necessary to keep this DX homebrew biggie aloft.

Photo A. Tom Mackay, W6WC, prepares to assemble the BlueSky Lite mast for a southern California 2007 Field Day operation. (WB6NOA photo)

The BlueSky Lite 30-foot mast kit includes the following components, compartmentalized in the heavy-duty Cordura® rolling bag:

- Seven blue anodized-aluminum mast sections, 2.75-inch OD, 48 inches tall, predrilled for locking pins (supplied)
- Complete UV-resistant black guy-rope system, with collars and professional ground stakes
- Two-pound hammer for the ground-stake task
- Pre-mount top-section antenna pole, 24 inches, with generic antenna mounting plate (see paragraph after list)
- Base plate for ground mounting, including base plate stakes and the 2-lb. hammer
- Lock-hitch pins for securing poles together
- Lock-hitch pins for securing guy rings
- Detailed instruction manual
- Optional trailer-hitch mount and mast adapter

The top-mount flat mounting plate has been pre-drilled to accept an electric rotator assembly (flat), or to accommodate nearly any configuration of U-bolts to

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Photo B. The BlueSky Lite mast sections slip together and lock in place in seconds. (WB6NOA photo)

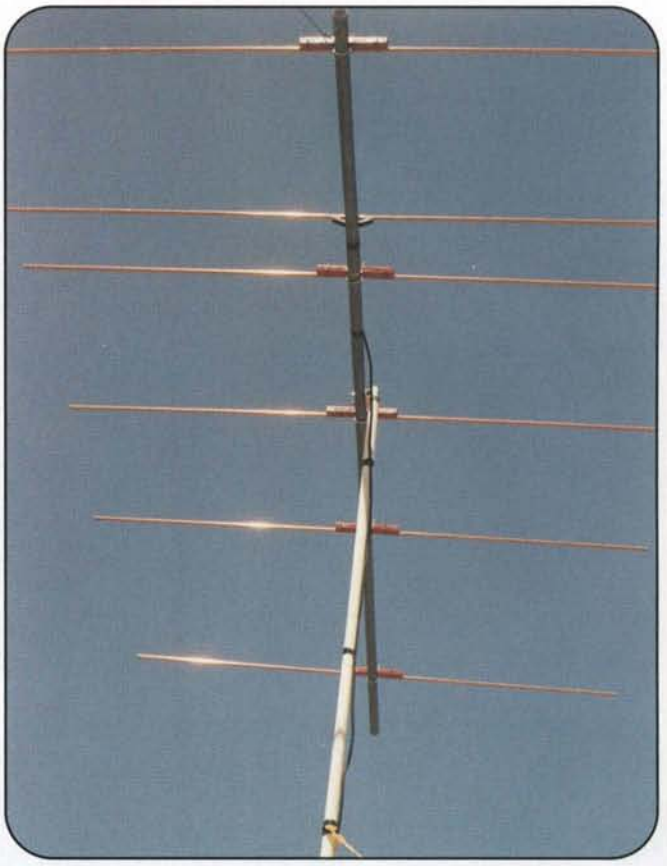

Photo C. This heavy-weight homebrew 6-meter beam "noodled" on a conventional mast but stayed steady on top of the BlueSky Lite mast. (WB6NOA photo)

secure a beam or horizontal mast section for a pair of VHF/UHF phased beams. There are so many holes in the supplied top plate that there is little chance you would ever need to drill any more for almost any type of rotor or U-bolt

Each blue anodized-aluminum mast section slips and interlocks into the next section so they won't turn within each other. You can use as few or as many of the sections as you need to get your VHF/UHF antennas up in the air when operating rover.

"We have seen ham radio operators configure the antenna to 30 feet with more than 20 lbs. of antennas and the rotator on top," adds Scott Vanover, of BlueSky Mast, Inc., parent company of BlueSky Lite, LLC.

The sturdy ground plate, with the supplied ground stakes, keeps the base from jumping out of position, but allows the base to hinge the masts up. For rovers, you may wish to order the optional trailer -hitch assembly, which would allow the mast sections to simply slip in and secure.

"I like the BlueSky Lite with the optional trailer-hitch mount on my Blazer and my Hex-Pac (www. Hexbeam. com), which allows me to put together a monoband Hex beam in 10 to 15 minutes, covering any band from 6 meters through 20 meters," comments Barry Johnson, W4WB.

"The 20-meter beam weighs just over 7 lbs., and I can get it up in the air with the trailer-hitch BlueSky Lite mast system all by myself. Now I will be more willing to visit the in-laws," adds Barry.

In looking over the complete mast system, it looks as if BlueSky Lite is meant to replace the common, heavy, green,

Photo D. The sturdy mast bag rolls easily on the oversize wheels. (WB6NOA photo)

military mast sections. If you have worked with those military mast sections, you will appreciate the precision of matching and connecting these anodized aluminum mast sections and disconnecting them without jamming. Also, of course, like their military heavy mast counterparts, BlueSky won't noodle!

"Since 9/11 and Katrina, it has become apparent that mobile solutions are needed for mast deployment, not just at the military level but at all levels, including state and local government, FEMA, Red Cross, and amateur radio," comments Scott

Photo E. BlueSky Lite 30-ft. antenna mast kit as it comes from the manufacturer. (BlueSky Lite photo)

Photo F. The safety-wire locking pin keeps the interlocking poles safely together. (BlueSky Lite photo)

Photo G. BlueSky Lite universal antenna mounting plate holds a ground-plane antenna in place. (BlueSky Lite photo)

Photo H. The base plate of the BlueSky Lite antenna mast. (BlueSky Lite photo)

Vanover, of BlueSky. "Our BlueSky Lite masts were developed to bridge the gap that exists between military requirements, and commercial budgets by offering an economical mast to support the commercial needs of light duty portable antenna applications."

" I figured the mast would support the Hex beam, and probably the Yaesu G-1000 DXA rotor mounted at the top of the mast, with everything weighing around 70 lbs., and was quite surprised that it went up as easily as I had hoped," says Barry, W4WB. This larger-than-usual assembly of the 40-ft. diameter Hex beam up 50 feet took 12 people but only 15 minutes to get it up in the air. Barry's K4BFT team made almost 1100 QSOs on 40 meters SSB during Field Day, an impressive score for using an antenna that went up so quickly from scratch, thanks to the aluminum masting.

The suggested retail price of the BlueSky Lite 30-ft. commercial/amateur radio mast system is $795, and this includes the sturdy triple-wheel bag for easy transport. Total weight is 58 lbs., but once you roll it out of the back of the pickup, one person can easily bring the mast system over rough ground into position for setup. This system is a keeper non-noodler for the serious VHF/UHF rover.

By Joe Moell,* KØOV

HOMING IN

Radio Direction Finding for Fun and Public Service

RDF Protects Lives, Provides Fun, and Promotes Goodwill

"Thanks for all of the fun and experience that I have gotten through Amateur Radio Direction Finding (ARDF). It really paid off this week!" That's what Sam Vigil, WA6NGH, wrote in an e-mail that I received. He was referring to the radio direction finding (RDF) skills he developed in recent years that made him a key player in finding a lost Alzheimer's patient. When persons with dementia wander away from home, most are recovered within two miles. However, this 83-year-old victim traveled over 16 miles, but I'm getting ahead of the story.

Sam and his wife Eve, KF6NEV, were among the first to volunteer when Project Lifesaver began in their area three years ago. About 35 local citizens with Alzheimer's disease and developmental disabilities are wearing wristband transmitters that can help searchers quickly find them if they wander away from home. Just like wildlife research radio tags, these transmitters emit 25-milliwatt pulses at about 1-second intervals on individually assigned frequencies near 215 MHz.[1] Sam and others have spent many hours in training to rapidly perform RDF on these pulsed signals from the air and on foot.

RDF Rescues a Biker

The San Luis Obispo Project Lifesaver team was called into action on December 10, 2007 to find a Pismo Beach man in the first stage of Alzheimer's disease. "He is very fit physically," Sam wrote. "He has good long-term memory, but is deficient in the short term. His wife reported him missing when she came home from work at 5 PM."

Sam continued, "Eve and I responded with three other direction finding teams, checking for his wristband signal on all streets for a 2-mile radius. We knew that he was on a bike, but didn't find out until about 30 minutes into the search that his range of biking in the past has been from San Luis Obispo to Santa Maria, which is 35 miles! From past testing, we knew that the range of the transmitters is only about a mile, so we needed air support. Project Lifesaver normally utilizes California Highway Patrol (CHP) or Vandenberg Air Force Base helicopters, but Santa Barbara County came through first this time.

"Eve and I boarded at Oceano County Airport at 9 PM. The orders of Incident Commander Jon Wordsworth were for our pilot to fly south to Santa Maria and work our way back north. As soon as we crossed the Santa Maria River, I picked up a weak signal. For the next 20 minutes, we followed the biker around the north side of town as we called in the three ground teams. Just as the first team got there, we had to leave to refuel, which took about 15 minutes. When we got back over town, the signal was gone!

Sam Vigil, WA6NGH (left), with the crew chief of the helicopter team that used RDF to help find a missing Alzheimer's patient in December. (Photo courtesy of Sam Vigil, WA6NGH)

"As we tried to re-acquire the signal, we got a radio call that one of the ground teams was hearing it weakly to the north of Santa Maria. We headed north across the river and immediately picked it up. We were not able to see the biker, even with the Night Sun searchlight and night-vision goggles. Nevertheless, we were able to vector in the ground teams with our bearings.

"By then, the patient had reversed direction and was heading south again toward the Santa Maria River. The river is pretty dry, but we were concerned that if he went down into the riverbed, the ground teams would have great difficulty finding him safely. Fortunately, he was starting to slow down. At 10:38 PM, a ground team spotted him on a frontage road next to Highway 101. He was in good shape, with mild dehydration, and was medically released to his wife that night."

There is no question that RDF played a vital and possibly lifesaving role in this rescue. By contrast, Sam tells of another dementia victim in his area who wandered away in 2005: "That subject was not wearing a wristband transmitter. It took three days and two nights, over 120 searchers from four counties, and three helicopters. When found, he was near death from hypothermia and dehydration."

The standard ground and airborne RDF antenna for Project Lifesaver is a lightweight 3-element Yagi, but volunteers and pilots agree that the 2-foot long elements of this antenna are very awkward inside a helicopter. Externally mounting the Yagi is not practical because any one of a large number of aircraft might be called for a search. Sam said, "In some jurisdictions, they open the door and put the DFer out on the skid in a harness! The CHP is unwilling to do that."

WA6NGH got the idea of using a cubical quad, which at 215 MHz has square elements that are only about one foot on a side. In addition, VHF transmitter hunters have discovered that quads

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Eve Vigil, KF6NEV, gets airborne bearings with a home-built 215-MHz cubical quad. Compared to an equivalent Yagi, she found that it is better performing and easier to use in the helicopter. (Photo courtesy of WA6NGH)

are less affected by nearby objects than equivalent Yagis. Sam scaled down the 2-meter stiff-wire quad design from my book[2] and optimized the gamma match. "Now we can do direction finding from the safety and relative comfort of the chopper's back seat, shooting through the Plexiglas," Sam reported. "The quad is not only easier to handle, but its performance is better than the Yagi."

Other hams involved in this search were, in alphabetical order, Mark Calcagno, KC6BAZ; Anne Marie Foster, KI6BMC; Claudia Hayner, KG6AKN; Donald "Rusty" Hobbs, N6OCR; Beth Ries-Wordsworth, WD4NGU; Dave Smee, KG6TXN; and Jason Waddell, KF6BOP.

"You don't have to be a ham to do Project Lifesaver tracking," said Sam. "Some are not. But I think that my ham background and most importantly my ARDF experience have made a difference in my ability." WA6NGH tried foxhunting for the first time at the 2003 ARRL Southwestern Division convention hunt that I put on in San Pedro, CA. After a few more local events, he entered the 2004 USA ARDF Championships in southern California. He also took to the forest courses at the 2006 championships in North Carolina.

Project Lifesaver began in Virginia eight years ago and has expanded steadily ever since. In addition to the San Luis Obispo group, I have heard from hams in Yamhill County, Oregon and Elkhart County, Indiana who are using their RDF skills in the program. For more information about Project Lifesaver in California, contact Jon Wordsworth, the State Coordinator.[3] Elsewhere in the USA, visit the Project Lifesaver International website.[4]

Lessons from the Ukraine

It isn't often that I get to spend an evening combining two of my favorites pastimes—ARDF and fine music. When Marvin Johnston, KE6HTS, e-mailed me to invite my wife April, WA6OPS, and me to meet Igor Lazarev, USØVA, we already had plans to get together with two other hams at a Christmas concert in Pasadena. We invited Marvin and Igor to join us at the evening event and they accepted.

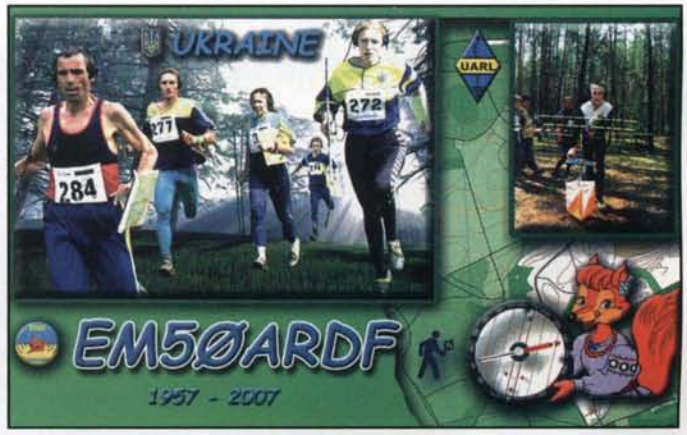
In five vehicles, we all converged on the Pasadena church just in time, including Igor, who had successfully followed our directions from the Los Angeles airport with neither a ham transceiver nor a cell phone. After the concert, Igor and the group were treated to a tour of the inner workings of a pipe organ and a visit to a satellite earth station in Burbank, all while chatting about ARDF in our respective countries. It was international goodwill at its finest through amateur radio.

USØVA is an orthopedic scientist. His expertise is in the treatment of patients recovering from disease and trauma to muscles, bones, tissues, and nerves. The equivalent medical specialty in the USA is physiatry. With this background, Igor was an excellent choice to be the primary physician for the 23-member Ukrainian ARDF team. His wife Nataliya, who could not go on this brief trip to the USA, is a gynecologist who handles medical issues of the girls and women on the team.

Marvin and I peppered Igor with questions to help us understand the constant superiority of the Ukrainian ARDF program. April, who has been the Field Medic for recent USA championships, wanted to know all about treatment of sports injuries during training and competitions in Europe. Another topic was the difficulty of obtaining visas for some countries' visitors to ARDF events in the USA.

The Ukraine is the second largest country in Europe, approximately the size of Arizona and New Mexico combined, with 46-million inhabitants. When the first Ukrainian ARDF events were held near Kiev in 1957, Nikita Khrushchev was at the height of his power and this region was part of the USSR. In those days, international-rules radio-orienteering was strictly a

Igor Lazarev, USØVA (left) of the Ukraine and Marvin Johnston, KE6HTS, get a satellite uplink station tour from Christie Edinger, KØIU. (Photo by Joe Moell, KØOV)



The Ukraine celebrated 50 years of ARDF participation last year with a special event station and an award for working radiosport participants on the air. (Courtesy KARL)

Serhiy Zarubin of the Ukraine won a gold and a silver medal at the USA ARDF Championships in 2001. He took the mic at the awards ceremony to thank all for their hospitality. (Photo by KØOV)

European sport, closely tied to the military and government schools in Soviet countries. The USSR was always near the top of the medal count at the World Championships.

With the breakup of the Soviet Union, the Ukraine became an independent republic in 1991. Former Soviet countries then began competing against one another at ARDF contests, where Ukrainians were and continue to be in the top tier. At the most recent World Championships in 2006, Ukrainians took home 15 medals, including seven gold. At least one Ukrainian finished in the top five in every age/gender category on 80 meters, and in all but one category on 2 meters.

Serhiy Zarubin and Volodymyr Griedov, UT5UAZ, of the Ukrainian ARDF team came to the USA in 2001 to compete as visitors in the First USA ARDF Championships in Albuquerque, New Mexico. They took first and second place overall in their age category on both 2 meters and 80 meters. Serhiy completed the 80-meter five-fox hunt in less than 37 minutes, setting a USA Championships course record that has not been broken since.

What are the reasons for the Ukrainians' success? First and foremost is constant training. As soon as the snow clears, regular local events begin all over the country. Competitors measure their skills against one another weekly through the spring and summer. Second, the old ties to the country's schools and conscription-based military remain strong. For those in the military, there is extra incentive to do well.

The Ukraine's national championships select the best foxtailers in each age/gender category, who receive additional training and medical support as they prepare and travel together to the World Championships. National funding to support Ukrainian ARDF is down markedly from years past, but a strong program continues with volunteer support.

Stateside hams can't emulate the concentrated national training regimen of the Ukrainians, because the continental USA is 16 times larger and travel costs would be prohibitive. Our once-a-year championships have drawn radiosport enthusiasts from Santa Barbara to Boston and Seattle to Daytona. We need concentrated training in all those communities and elsewhere in our country. You can get involved by organizing ARDF classes and practice sessions in your own area, as well as by promoting the sport to your local ham clubs, schools, and Scouts.

Like our ARDF national championships, the Ukrainian nationals are open to all. Igor wants stateside radio-orienteers to visit his country this spring. Ukrainian championships will be at the end of April and beginning of May. Besides learning and competing, you can take tours of the country, including a visit to the infamous Chernobyl reactor site on the Belarus border.

An Invitation to Texas

In the last issue of *CQ VHF*, I recalled the fun and excitement of the USA's seventh national ARDF championships. If that made you resolve to attend this year's championships, you can start making plans now. Your destination will be Austin, where the Texas ARDF group and the Houston Orienteering Club (HOC) will set foxtailing courses near the 175-year-old town of Bastrop on the second weekend of May.

It's hard for non-Texans to imagine pine forests anywhere but on the east coast of the Lone Star State. However, Bastrop and Buescher State Parks, about 30 miles from Austin, are full of loblolly pines. You may hear them called the Lost Pines, so named because the area is over 150 miles from the large forests of east Texas. You could choose to believe the legend that ancient tribesmen took seedlings westward with them to combat homesickness, or you could trust the scientists who say these pines are there because of glacial activity. Pollen studies show that they started growing in Bastrop County about 18,000 years ago.

This is rolling terrain, with much less elevation change than last year's mountain sites near Lake Tahoe. Besides pines, the parks feature unusual ferns and fungi. You might encounter a deer, raccoon, or armadillo between the radio foxes. You will definitely hear and see birds, because over 250 winged species have been documented there. If running with radios and communing with nature isn't enough for you, there is an 18-hole golf course in Bastrop Park.

Bastrop Park also has small ponds that are home to the endangered Houston Toad. You may not see these 3-inch critters, because they have evolved coloration and a rough skin for protection from predators. Despite the camouflage, their numbers are dwindling. There are probably less than 4000 adults of the species left in the world, so large areas of the park are closed during the February through April mating season. That is why the championships are taking place on the second weekend of May. The toad closure is over by then, and it's not yet too hot for comfort.

HOC has produced excellent orienteering maps that will be used for this event. Bastrop Park is so popular for map-and-compass fun that HOC has placed about 100 permanent wooden markers throughout. Visitors can try their hand at classic orienteering on any day that the park is open. However, if you plan to compete there in May, don't do it yet. Bastrop and Buescher parks are currently under embargo for ARDF competitors. That means that you are not permitted to go into these woods in advance to get the "lay of the land." The goal of the embargo is for everyone at the 2008 championships to experience the park as a newcomer, with no unfair advantage of familiarity.

To give participants the option to get home in time for Mother's Day, this year's USA championships will be Thursday, Friday, and Saturday. May 8 will be arrival and equipment testing day, with a few 2-

Wet but happy, here's Ken Harker, WM5R, of Texas near the end of his bronze-medal-winning 2-meter run in the rain at the 2006 USA ARDF Championships in North Carolina. This year, he and his wife Jen, W5JEN, are co-chairs of the USA ARDF Championships in Texas. (Photo KØOV)

On her way to a gold medal, Jen Harker, W5JEN, heads out the 2-meter starting corridor in North Carolina during the 2006 USA Championships. (Photo by KØOV)

In September 2006, Nadia Scharlau of North Carolina was the first American to win a medal at the ARDF World Championships. (Photo by Richard Thompson, WA6NOL)

meter and 80-meter transmitters on the air near event headquarters. There will also be a get-acquainted meeting and drawing for starting order. The 2-meter contest will be Friday morning, with competitors starting in small groups made up of different age/gender categories, in the drawn order.

The 80-meter event will be Saturday morning with starts in reverse order, highest numbers first. After everyone returns from the woods and the results are tallied, medals will be presented.

Organizing co-chairs for the 2008 USA Championships are Kenneth and Jennifer Harker, WM5R and W5JEN, respectively. They competed at the USA Championships in 2003, 2005, 2006, and 2007. Each won medals on both bands at the 2007 USA ARDF and IARU Region 2 Championships near South Lake Tahoe. Ken and Jen organized the first Texas ARDF Championships in October 2005.

It will be easy to fly to the 2008 USA Championships, thanks to the new Austin-Bergstrom International Airport (IATA code AUS). It is 25 miles from the park and provides non-stop service from 46 airports around the country. AUS was proclaimed the best domestic airport in North America for 2006 by Airports Council International.

Registration for the 2008 USA championships should be open by the time this issue reaches you. The Texas ARDF website[5] is the place to go for detailed schedules, frequencies, lodging information, and registration forms.

As always, the USA ARDF Championships will be open to anyone of any age who can safely navigate the woods. A ham radio license is not required, but it greatly adds to the fun. Each person competes as an individual; there is no teaming or human assistance allowed on the courses. GPS help isn't allowed either! Also, of course, you can't use wheeled conveyances.

You are responsible for providing your own RDF gear. If you inquire ahead of time, you will probably find equipment that can be loaned to you. Only non-radiating receivers are permitted. Transmitting on the course is forbidden, except in an emergency.

If you have never participated in an international-rules transmitter hunt, be sure to read up on the sport in past issues of *CQ VHF* and at my website.[6] You will find the basics, rules, signal parameters, and equipment ideas, and you can determine your own age category. Be sure to look over the photos from our championships of previous years to see what the well-dressed radio-orienteer wears.

By happy coincidence, part of this event will take place during the CQ Worldwide Foxhunting Weekend. Even if you can't travel to Texas, be sure to arrange some foxhunting fun in your home town on that weekend and send the results to me for an upcoming article in *CQ* magazine.

From Austin to Seoul

As in previous even-numbered years, the USA ARDF Championships are taking place in the spring so that participants can qualify for the USA's World Championships team. This year's team positions will be offered to best performers in each age/gender category at the upcoming Texas event and last September's event near Lake Tahoe. Only three persons per category may be on a nation's team. Team members will travel to South Korea for the 14th World Championships of ARDF from September 2–7.

This is the first time that the Korean Amateur Radio League (KARL) has hosted the World Championships, and it's only the second time that the World Championships have taken place outside Europe. KARL has selected forested sites in the Gyeonggi province, about 30 miles from Seoul. Participants will be housed in a nearby resort hotel.

After invitations to join Team USA are extended to USA Championships winners, any remaining positions are open. However, individual applications directly to the Korean organizers are not permitted. Each country's team and visitor roster must be submitted by its national ARDF Coordinator.

An individual entry fee of US$400 covers lodging and food for the entire World Championships competition period plus a sightseeing day and souvenirs. Team USA's competitors and visitors are responsible for this fee plus their own transportation to and from Seoul.

If you are interested in traveling to the 2008 World Championships as a competitor or spectator from the USA, please contact me by e-mail or postal mail to the addresses at the beginning of this column. If you have not been on Team USA before, include your full name, callsign, mailing address, home phone number, and date of birth. Canadians should contact Joe Young VE7BFK.[7] Persons from any other North or South American nation should contact Dale Hunt, WB6BYU.[8]

At the last World Championships in Bulgaria two years ago, the USA was awarded its first medal.[9] Perhaps you have what it takes to be our next medalist. Start practicing and training now. I hope to see you at the USA championships in May. 73, Joe, KØOV

Notes

1. For more on small pulsed transmitters and receivers in the 200-MHz region, see "Homing In" in the Spring 2006 issue of *CQ VHF*.
2. Moell and Curlee, *Transmitter Hunting —Radio Direction Finding Simplified*, Chapter 4. Information at <http://members. aol.com/homingin/THRDFSinfo.html>.
3. <esgo@aol.com>
4. <http://www.projectlifesaver.org>
5. <http://www.texasardf.org/usa2008/>
6. <http://www.homingin.com>
7. <ve7bfk@rac.ca>
8. <wb6byu@arrl.net>
9. See "Homing In" in the Fall 2006 issue of *CQVHF*.

IARU International Satellite Forum Report

A frequency wish list and congestion on 2 meters were the main topics at the IARU International Satellite Forum in 2007. Here is ZS6AKV's report.

By Hans van de Groenendaal,* ZS6AKV
IARU Satellite Adviser

The IARU International Satellite forum meets annually to discuss issues that are of relevance to the amateur radio satellite fraternity and informs the IARU Satellite Adviser on items that should be brought to the attention of the IARU Administrative Council. The forum is hosted in alternate years in the USA as part of the AMSAT NA Space Symposium and in the UK as part of the AMSAT UK Satellite Colloquium.

AMSAT NA hosted the forum at the Pittsburgh Space Symposium in October 2007. The main topics of discussion were a frequency wish list for future allocations and congestion on the 2-metre band.

The IARU annually updates a wish list, which the organization representing all national amateur radio societies uses to form the basis for its interaction with the ITU and the World Radio Conferences. For years, the international satellite community has not produced any input for this list. However, with many recent developments, the AMSAT NA forum resolved that a wish list should be developed and submitted to the IARU for consideration.

After considerable debate, the following wish list was decided upon. Individual radio amateurs and AMSAT organizations worldwide are asked to give further input before a final list is submitted to the IARU Administrative Council. AMSAT groups on the international list will be canvassed. It will also be necessary to develop a set of justifications as to why these additional or revised allocations are important for future development. Input and comments should be sent to <zs6akv@amsat.org>.

The following are being put forth for for consideration:

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Congestion on 2 Meters

The worldwide band plan for satellite operation is 145.800–146.000 MHz, which simply is not enough to accommodate the many satellites being built.

A proposal "to permit satellites operating in the Amateur Satellite Service which incorporate linear transponders for CW and SSB activities to use, on a non-exclusive basis, the section of the 2 metre band 144.310–144.370 MHz for downlink (satellite to ground) mode only" had been rejected at the IARU Region 1 Interim Meeting in Vienna earlier in 2007.

A further proposal is now on the table for the IARU Region 1 Triennial Meeting in Nov 2008: "To permit satellites, operating in the Amateur Satellite Service, which incorporate "linear" transponders, which are generally used for narrow band non-channelized signals, to use, on a *non exclusive basis,* the section of the 2 metre band 144.005–144.045 MHz for downlink (satellite to ground) mode only, by amending the band plans in each IARU Region."

Before such a proposal can be brought forth, it will be necessary to consult with the EME (Earth-Moon-Earth) fraternity, as it was an allocation used for EME, but in general is no longer used today,

Band	Proposal
50–51 MHz	Seek new harmonised Amateur Satellite Service E-S and S-E allocation for communication and propagation research complementing existing Amateur Service requirements.
438–440 MHz	Extension to existing allocation E-S and S-E
1.240–1.250 MHz	E-S and S-E
2.300–2.330 MHz	E-S and S-E
2.390– 2.400 MHz	E-S and S-E Currently primary in USA 2 390 – 2 395 MHz and shared Primary 2.395–2.400 MHz
3.400–3.410 MHz	E-S and S-E Already available in Regions 2 and 3 This is an urgent request as current lack of allocation in Region 1 is limiting the use of this band.
5.650– 5.670 MHz	E-S and S-E
10 GHz	Satellite Service requires 10 MHz allocation. 10.360–10.400 MHz and work towards 10.450–10.460 MHz as Primary.

E-S is "Earth to Space"
S-E is "Space to Earth"

145.800–146.000 MHz Downlink Only

The presence of interfering non-amateur signals in the 145.80–146.00 MHz part of this band in many parts of the world is well documented. To prevent the retransmission of interfering terrestrial signals, satellites in the Amateur Satellite Service that plan to use the 2-metre amateur band for transponder operation are encouraged to use this band for downlink (satellite to ground) modes only, regardless of modulation type.

It was further recommended that satellite builders consider 70 cm and higher frequencies for further projects.

The next forum will be held in conjunction with the AMSAT UK Colloquium in July 2008.

By Keith Pugh,* W5IU

SATELLITES

Artificially Propagating Signals Through Space

The New World of AMSAT

In the last issue of *CQ VHF* we reviewed satellite basics. This time we will discuss the new world of AMSAT as introduced at the 2007 AMSAT Space Symposium in October 2007. Along with this comes the need for reinforcement of a "can do" attitude for amateur radio satellites and space programs.

Return to High Earth Orbit Satellites

Since the demise of AO-40, amateur radio operators have not had access to a HEO (High Earth Orbit) satellite and much discussion has taken place bemoaning this fact. Satellite builders in the various AMSATs have been trying to fill this gap as quickly as possible, but this has not been very fast. Most of the delay can be traced to one item—money (or the lack thereof). In this day and age there is "no free *launch,*" and the costs of designing, building, and testing continue to mount.

The Phase 3E program of AMSAT-DL is nearly ready to launch after a long design effort, but no affordable launch is currently available and funding for the AMSAT-DL laboratory has been curtailed. German funds *may* be available soon, but they are contingent upon the status of the Phase 5 (Mars Orbiter) program. Meanwhile, AMSAT-NA and AMSAT-UK have provided funds to keep the laboratory and design team together until the satellite can be declared "ready to launch" and be placed on the shelf until a launch can be initiated.

The AMSAT-NA Eagle Project is proceeding along in spite of some required re-design, but this is at a fairly slow pace largely due to weak funding. AMSAT-NA plans to continue this project to completion, but greatly enhanced funding is required for completion and launch. No firm, affordable launch opportunity for Eagle is available at this time. Meanwhile, design, prototyping, and testing continue in the new AMSAT-NA laboratory and other locations. Clearly, help is needed for this project to continue.

The timetables for Phase 3E and Eagle are uncertain until funding and launch opportunities can be firmed up. Hopefully, something will be found by the end of 2008.

Enter "Phase 4 Lite"! At a small satellite conference last summer, Lee McLamb, KU4OS, learned of an opportunity to partner with a major commercial satellite contractor for integration and launch of satellite payloads utilizing surplus capacity that now exists in commercial programs. AMSAT-NA officials jumped on this opportunity, prepared proposals, conducted talks, and have received the "go ahead" to announce

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potential teaming with Intelsat for this effort. This could lead to a ride(s) to geosynchronous orbit as well as other launch opportunities for Phase 3 satellites such as Phase 3E and Eagle. This opportunity is not for a "free launch," but it carries with it the potential to interest larger funding sources for the effort than AMSAT has been able to attract in the past. More details will be provided about this later.

Phase 4 Lite

Phase 4 Lite would be a payload on board a geosynchronous satellite that would provide 24/7 coverage to approximately one-third of the Earth. It would utilize the Eagle communications design to the greatest extent possible, but would not require the overhead design of items such as power systems, space frame, propulsion system, stabilization system, environmental control, etc., that would be provided by the parent satellite. Whole Earth coverage would eventually be possible, but would require at least three satellites and connecting ground links.

Hardware and software would be designed, built, and tested to high-reliability requirements that would ensure (to the extent possible) a 15-year life span in orbit. Once developed, this hardware and software would be directly available to Eagle and other projects. Frequencies and modes utilized would be optimized for the missions of the satellite and would be software defined to the greatest extent possible for flexibility. Back-ups would be provided where single-point failure analysis and other techniques indicate they are necessary to guarantee the 15-year life span of the satellite.

Primary missions for this satellite are wide area, inter-operable, emergency communications available to all agencies and education outreach. Along with these missions, other missions are possible for use by all amateur radio operators. Since amateur radio frequencies would be utilized for all missions, hams would be required for operation in all missions. Two principal reasons can be given for the choice of missions:

1. These missions would benefit all citizens of the world.
2. Since a great need is seen for these missions, funding can be raised from sources that have not before been approachable.

Ground stations for this project must be developed concurrently and must be affordable by the average amateur radio operator. User terminals (stations) must be small, portable, and reliable. More complex stations may be required for control and linking. Ground stations can be produced and marketed by AMSAT in fashions similar to those used by TAPR and others. Kits and other fabrication techniques can be utilized.

There is an opportunity for all types of hams to be involved in this project. Satellite builders, ground-station builders, fund raisers, emergency coordinators, educators, operators, etc., all are needed.

"Can Do"

For a project of this magnitude to come to fruition, development of a "can do" attitude is required. Recent correspondence on amsat-bb and in other places has shown that a lot of self-serving, "let the other guy do it" sentiment is out there. Yes, hams do have a right to have fun, too, but fun can be had along with participation in a worthwhile project that will benefit everyone. A great deal of personal satisfaction can be obtained from a job well done that benefits everyone. An attitude change from "what will you give me?" to "how can I help?" will go a long way towards reaching the goal.

Search through your personal capabilities and resources and contribute whatever, whenever, and wherever you can. Recently, appeals have gone out for designers, builders, testers, and educators. Please respond with "can do."

Summary

Building and launching amateur radio satellites is challenging, but most hams can contribute something to the effort if they will just allow themselves to think about it. No, you don't have to be a rocket scientist to participate in building amateur radio satellites. However, if you simply will allow yourself to keep an open mind and learn while doing, you may *become* a rocket scientist. Please support the AMSATs of the world in their dedicated efforts to provide us with the satellites we love and need.

I hope this hasn't sounded like "preaching to the choir," but I felt that it needed to be said. Enjoy the LEO (Low Earth Orbit) satellites that continue to operate for us, but support the return to HEO for the benefit of all amateur radio operators and the citizens of the world.

73, Keith, W5IU

By Dr. H. Paul Shuch,* N6TX

THE ORBITAL CLASSROOM

Furthering AMSAT's Mission Through Education

To the Moon, Alice!

Want to go to the Moon? If you're of the Apollo generation (as, in fact, are most AMSAT members), having come of age in the shadow of "one small step," you probably hesitated less than the blink of an eye before answering in the affirmative. After all, if we can put a man on the Moon, we reason in an expression of frustration with current NASA priorities, why can't we put a man on the Moon again?

The next best thing would be to orbit the Moon, and if we can do so with amateur radio equipment on board, so much the better. Over the next few years we just might have not one, but two chances to do so. At the August 2007 Small Satellite Conference at Utah State University, a couple of interesting opportunities were discussed.

ESMO, the European Student Moon Orbiter, is an ESA (European Space Agency) initiative to deploy a spacecraft carrying a student-designed science package into lunar orbit by 2011. This third mission of the SSETI (Student Space Education and Technology Initiative) has the following four broad objectives:

• Education—prepare students for careers in future projects of the European space exploration and space science programs by providing valuable hands-on experience on a relevant and demanding project.

• Outreach—acquire images of the Moon and transmit them back to Earth for public relations and education outreach purposes.

• Science—perform new scientific measurements relevant to lunar science and the future human exploration of the Moon, in complement with past, present, and future lunar missions.

• Engineering—provide flight demonstration of innovative space technologies developed under university research activities.

As proposed, the ESMO payload would be inserted into GTO (Geostationary Transfer Orbit) on either an Ariane V or a Soyuz launch vehicle. According to the ESMO website, "from GTO, the 200 kg spacecraft would use its on-board propulsion system for lunar transfer, lunar orbit insertion, and orbit transfer to its final low altitude polar orbit around the Moon. A 10 kg miniaturized suite of scientific instruments (also to be provided by student teams) would perform measurements during the lunar transfer and lunar orbit phases over the period of a few months, according to highly focused science objectives. The core payload would be a high resolution narrow angle CCD camera for optical imaging of lunar surface characteristics.

"Optional payload items being considered include a LIDAR, an IR hyper spectral imager, a mini sub-surface sounding radar for polar ice detection, and a Cubesat sub satellite for precision gravity field mapping via accurate ranging of the sub satellite from the main spacecraft." As would be expected, several European AMSAT organizations (including AMSAT-UK and AMSAT-DL) are lending support for this exciting mission opportunity.

Not to be outdone, in the U.S., the NASA Office of Education has proposed an ASMO (American Student Moon Orbiter) to be both competitive and cooperative with the European mission. ASMO, according to NASA, "offers to next generation explorers unique opportunities for integral involvement in the U.S. space exploration program. The ASMO project will be carried out as a diverse nationwide higher education initiative by which American university students and their faculty advisors will design, build, register, launch, and own the ASMO small spacecraft and its payload."

Why would NASA risk turning over a major component of its lunar research to a group of students? During the years of the Apollo program, the average age of NASA's workforce was 26. Today, NASA employees average 47 years of age, with 25% eligible for retirement within the next five years. By bringing bright young technologists on board now, it is reasoned that NASA will have a shot at replenishing itself around the time those retirements kick in.

Both ESMO and ASMO will conduct scientific experiments in lunar orbit and very likely will employ amateur radio for telemetry, tracking, and control of their respective scientific missions. According to the NASA website: "The student-built ASMO craft could be launched to orbit the Earth's Moon in 2011 in tandem with a spacecraft to be developed by European students under a companion European Student Moon Orbiter (ESMO) program. Through coordination with ESA's ESMO program and possible spacecraft interoperability, valuable opportunities for international scientific and technical collaboration could be offered. Conceived to accommodate a 10 kg payload in a highly elliptical 2 year lunar orbit, there are numerous options for ASMO to serve as a valuable data gathering mission and technology demonstration that will enhance understanding of the lunar environment and advance the small satellite field."

Your humble Director of Education had the opportunity, at the aforementioned Small Satellite Conference, to meet with some of the student teams that are bidding on pieces of the ESMO and ASMO missions. These incredibly bright young men and women remind me a little of my fellow AMSAT members and,

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"One thing that every amateur moonbouncer knows is that it's a long way to the Moon, and until Congress sees fit to repeal the Inverse Square Law, free-space isotropic path loss is going to dominate comm. link design for these challenging missions."

yes, myself, more decades ago than I care to admit. They are mostly Aerospace Engineering students at some top colleges and universities, with their heads in the clouds in true "space cadet" fashion. Some are even licensed radio amateurs, having cut their technological teeth on CubeSat projects. However, in the areas of space communications and control, they appear to have only a limited understanding of the problems they are going to face, and little experience to apply to their solution. Here's where we come in.

To date, neither ESA nor NASA has officially requested AMSAT involvement in the ESMO or ASMO missions, respectively. However, given the likelihood of employing amateur radio frequencies, the expertise available within our ranks, and the educational focus of both missions, it stands to reason that we are in a position to offer technical assistance in the areas of frequency selection, modulation, and data-format tradeoff studies, communications link analysis, spacecraft comm. system design, ground station design and operation, and training support for the ASMO and ESMO ground crews (who, we certainly hope, will all become licensed radio amateurs some time prior to launch).

One thing that every amateur moonbouncer knows is that it's a long way to the Moon, and until Congress sees fit to repeal the Inverse Square Law, free-space isotropic path loss is going to dominate comm. link design for these challenging missions. Thus, to achieve any reasonable data rate over lunar distances, we're going to have to put our hands on some pretty big dishes in order to ensure mission success. The challenges of earth station design for a lunar mission will be explored in the next "Orbital Classroom" column.

—73, Paul, N6TX

By Bob Witte,* KØNR

D-Star Creates Band Planning Challenge

In the Summer 2007 issue of *CQ VHF*, I mentioned the challenge that frequency-coordinating bodies are facing with regard to coordinating digital voice (e.g., D-Star) repeater systems. The emergence of D-Star is putting pressure on the frequency-coordinating bodies to find a place in the spectrum. This challenge has caused significant debate within the ham community, and some frequency-coordinating bodies have now taken action.

What is D-Star?

D-Star (Digital Smart Technologies for Amateur Radio) is an open protocol for mixed digital voice and data, developed under the direction of the Japan Amateur Radio League (JARL). ICOM is currently the only equipment manufacturer to market D-Star radios and repeaters in the U.S. However, some hams have been homebrewing D-Star–compatible equipment.

For more information, see "D-Star Digital Voice for VHF/UHF," by Bob Witte, KØNR, *CQ VHF*, Winter 2006.

Discussion groups on the internet:

Illinois Digital Ham—Yahoo Group: <http://groups.yahoo.com/group/illinoisdigitalham/>

D-Star Digital—Yahoo Group: <http://groups.yahoo.com/group/dstar_digital/>

Frequency Coordination

Frequency coordination is a critical function for effective use of repeaters on the amateur radio bands, because repeaters are inherently fixed in frequency and usually fixed in location. Frequency coordination is a process that minimizes repeater-to-repeater interference by carefully planning separation in frequency and geography. This is a voluntary function, but has the strength of the FCC behind it. When it comes to interference issues, the FCC is crystal clear that coordinated repeaters take priority over ones that are not coordinated. Overall, it is a great example of how the Amateur Radio Service can self-regulate, with a little help from the FCC.

In many parts of the U.S. designated repeater pairs in the 2-meter band are all allocated—that is, the portion of the band designated for repeaters has a repeater coordinated on each channel. When a new request is made for a repeater coordination, there is no available frequency pair that can be used without causing undo interference to existing repeaters. The 2-meter band in the U.S. is only 4 MHz wide and serves a wide variety of interests—moonbounce, meteor scatter, weak-signal CW/SSB, FM simplex, FM repeaters, and satellite. The 70-cm band in the U.S. is 420 MHz to 450 MHz, which offers a much wider slice of radio spectrum. Still, the designated FM repeater portion of the band is also fully allocated in many areas.

2 meters	144 to 148 MHz
70 cm	420 MHz to 450 MHz
23 cm	1240 to 1300 MHz

Table 1. VHF/UHF amateur bands with D-Star equipment available (United States allocation).

Frequency coordination is a difficult and often thankless job. Potential repeater owners often come to the frequency coordinator with unrealistic expectations. They frequently do not understand the principles of spectrum management; they find an "open" frequency and want to plop a repeater on it. The frequency coordinator needs to make decisions that protect the interests of established repeaters while making room for newcomers. When the band gets full, this becomes a difficult to impossible task.

To determine your local frequency coordinating body, see the National Frequency Coordinators' Council website listed in the References section at the end of this article.

There is quite a buzz surrounding D-Star, fueled by ICOM's marketing efforts and the desire of many hams to experiment with new technology. Frequency coordinators are getting requests for D-Star repeater coordination, often for a "standard D-Star stack" of 2-meter, 70-cm, and 23-cm repeaters (see Table 1). (The ICOM D-Star system is set up to use one controller for up to four bands. A common configuration is to deploy D-Star on all three available bands: 2 meters, 70 cm, and 23 cm.)

Challenging the Rules

When faced with a problem (no repeater pairs on 2 meters), some hams start to "innovate" by carefully interpreting the FCC rules and regulations. It is an interesting process, as most of FCC Part 97 was written decades ago with a particular technical context in mind. The FCC rules are intended to last over time, but sometimes they have to be "re-interpreted" to remain relevant, or sometimes people just want to read their own agenda in the existing rules.

One argument that has recently surfaced is that D-Star systems are not really repeaters, so they aren't restricted to certain parts of the band. Since D-Star is a digital-modulation format, a D-Star repeater takes in a digital bit stream, processes it, and spits it back out. The processing causes a delay between the transmit and receive functions, so maybe this is really a "store and forward" digital system. If we interpret the rules that way, then we don't really have a repeater and we are no longer limited to the repeater section of the 2-meter band. This argu-

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A display of D-STAR equipment at the the Dayton Hamvention® (Photo by Bob KØNR)

ment was put forth to Bill Cross, W3TN, of the FCC, and Bill's reply appears to have validated the interpretation. The argument centers on the Part 97 definition of a repeater, which includes the word *simultaneously*.

FCC Part 97.3

(39) Repeater. An amateur station that simultaneously retransmits the transmission of another amateur station on a different channel or channels.

Certainly, if a system receives a transmission and stores it for a day and then retransmits it, it doesn't fit our concept of a repeater. However, what if it delays the transmission by 1 minute or 10 milliseconds? Now we are into shades of gray. Opponents of this "store and forward" argument point out that many conventional FM repeaters have a delay in their audio processing system. (This delay is used to filter out DTMF tones so they can be suppressed before they reach the transmitter.) If a short delay is an issue, then analog FM repeaters can provide enough delay to no longer be defined as repeaters. Said differently, small delays between transmit and receive signals are present in many repeaters and are inconsequential.

Another argument has been made that D-Star systems can be considered *Auxiliary Stations*. Part 97.3a defines an auxiliary station as "an amateur station, other than in a message forwarding system, that is transmitting communications point-to-point within a system of cooperating amateur stations." Perhaps a D-Star system fits this definition. If so, this opens up the 145.50- to 145.8-MHz portion of the 2-meter band for D-Star use. To understand this, we need to read Part 97 very carefully, as there is a slight difference between the 2-meter subbands that allow auxiliary and repeater operation (see Table 2). The segment of 145.5 to 145.8 MHz is allowed for auxiliary operation but *not* repeater operation. Per the ARRL band plan, this section of the band is defined as *Miscellaneous and experimental modes*. Hey, that does sound consistent with new whizzy technology like D-Star.

Both of these interpretations of Part 97 have caused heated debate among the National Frequency Coordinators' Council (NFCC), the national body for frequency coordination. The NFCC voted to ask the FCC to declare "all repeaters are repeaters" (see sidebar). That is, they reject the notion that D-Star systems

	Operation Not Allowed per FCC Rules (2m band)
Auxiliary Operation	144.0–144.5 MHz 145.8–146.0 MHz
Repeater Operation	144.0–144.5 MHz 145.5–146.0 MHz

Table 2. Auxiliary and repeater operation on 2 meters.

should be considered outside of the repeater subband.

Local Band Plans

As I mentioned in the Fall 2006 FM column, VHF/UHF band planning really is done locally. The ARRL has a band plan that provides general guidance for the U.S., but the details are worked out by local frequency-coordinating bodies. I won't repeat that information here, so take a look at that article if you want a deeper knowledge of band plans.

Based on the demand for D-Star repeater pairs and the desire to accommodate (and even promote) the adoption of new technology, some frequency-coordinating bodies have taken action.

In Arizona, the frequency-coordinating body designated four D-Star channels in the range of 145.100 to 145.160 MHz (with inputs at 144.500 to 144.560 MHz). Arizona had existing duplex pairs for digital operation (conventional AX.25 packet radio) in this range that they re-farmed for D-Star operation. They chose the channel spacing of 10 kHz, so these pairs are not going to be usable for APCO Project 25 repeaters, which require at least 12.5-kHz spacing. There is not much solid technical data available concerning the emission characteristics of D-Star, but most repeater groups working with the technology are adopting a min-

NFCC Asks FCC to Treat All Repeaters as Repeaters

The membership of the National Frequency Coordinators' Council has voted to ask the FCC to treat all repeaters as repeaters, regardless of mode or transmission protocol. The following motion was adopted:

That the NFCC send a letter to the FCC that states that the NFCC believes that any amateur station, other than a message forwarding system, that automatically retransmits a signal sent by another amateur station on a different frequency while it is being received, regardless of any delays in processing that signal or its format or content, is a repeater station within the meaning of paragraph 97.3(a)(39) of the rules of the Federal Communications Commission, and should be treated as such.

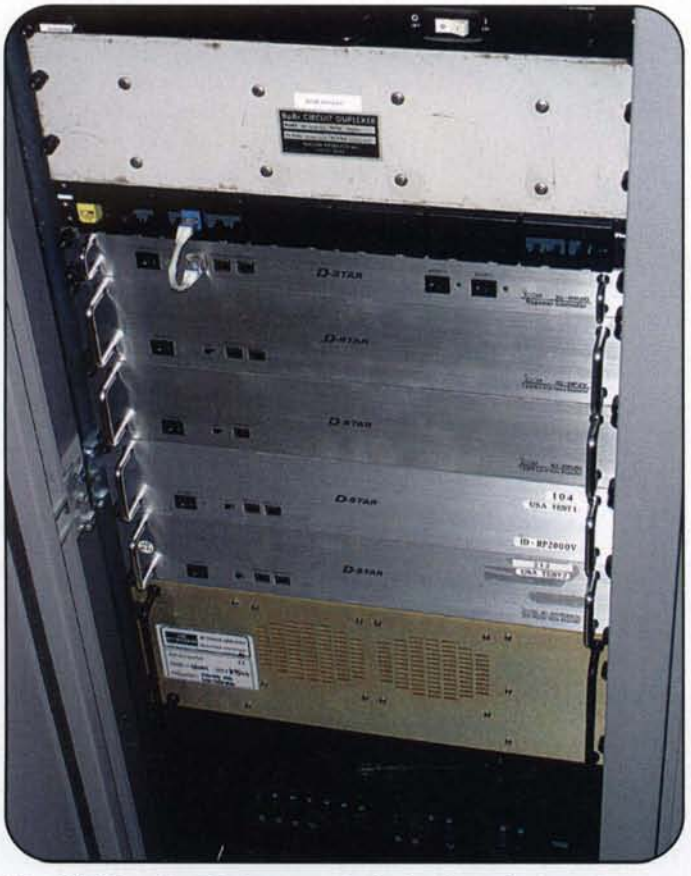
Under the NFCC's proportional voting system, 93 votes were cast in favor of the motion by 19 members, and 54 against by 11 members.

For the Council
Jay Maynard, K5ZC
President

imum channel spacing of 10 kHz. (Some of ICOM's marketing literature speaks of a 6.25-kHz bandwidth for D-Star emissions, but I have not found anyone whobelieves the channel spacing can be this tight.)

In Colorado, the Colorado Council of Amateur Radio Clubs (CCARC) adopted a proposal for the 70-cm and 23-cm bands but has not adopted any changes to the 2-meter band. (*Disclosure:* I chaired the committee that made these recommendations.) The CCARC adopted a 12.5-kHz channel spacing for digital voice to remain agnostic between D-Star systems and other competing standards such as APCO Project 25. The organization concluded that adopting 10-kHz channel spacing for a segment of the band would effectively make these "D-Star only" channels, something they wanted to avoid. The 12.5-kHz channel spacing is accomplished on 70 cm and 23 cm by splitting the existing 25-kHz channels into two narrow-band digital channels. On 70 cm, the CCARC created a narrow-band digital subband, 446.800 MHz to 447.000 MHz. Colorado has the repeater transmit frequency on the high side, so the repeater receiver frequency is 441.800 to 442.000 MHz for these pairs. This portion of the band was previously used for repeater linking (auxiliary operation) but is lightly used. On the 23-cm band the Colorado group adopted a flexible approach of allowing a mix of 12.5-kHz digital channels and 25-kHz analog channels (at the frequency coordinator's option). Of course, there are very few repeaters in the state on 23 cm, so currently this is not really a coordinating challenge.

The Florida Repeater Council followed an approach similar to Colorado, leaving the 2-meter band alone for now and adopting 12.5-kHz narrow-band digital channels on 70 cm and 23 cm.



The K5TIT rack of D-Star gear includes (in order, starting near the top of the rack) a D-Star repeater controller, 1.2-GHz voice repeater, 1.2-GHz data radio, 146-MHz voice repeater, and 446-MHz voice repeater. (Photo courtesy of Jim McClellan, N5MIJ)

The Southeastern Repeater Association (SERA) is studying the band-planning issues concerning digital voice repeaters and has not yet decided on a change to its band plan. The Illinois Repeater Association has a proposal on how to support migration to digital channels on its website (drafted by Robert Shepard, KA9FLX).

The Texas VHF-FM Society has adopted a *temporary* plan to accommodate digital voice repeaters in densely populated areas. On 2 meters they reassigned some simplex frequencies to be used for digital voice repeaters: 146.450, 146.460, 146.470, 146.480, and 146.49 MHz as repeater outputs, with the repeater input 1 MHz above (147.450, 147.460, 147.470, 147.480, and 147.490 MHz). The Texas band plan already had narrow-band digital channels designated on the 70-cm band, with repeater outputs at 440.525–440.725 MHz and inputs at 445.525–445.725 MHz.

One of the more controversial changes comes from the Two-Meter Area Spectrum Management Association (TASMA) in southern California. Using the "D-Star is a form of auxiliary operation" interpretation, TASMA has designated four D-Star frequency pairs in the 2-meter band. The not-a-repeater output frequencies are 145.585, 145.595, 145.605, and 145.615 MHz, with inputs 600 kHz below at 144.985, 144.995, 145.005, and 145.015 MHz. The outputs are in the "miscellaneous and experimental modes" section per the ARRL band plan. The inputs fall into a section that the ARRL lists as *Weak signal and FM simplex.* In many parts of the country, these frequencies are used for AX.25 packet operation.

As you can see, there is not a consistent approach to allocating narrow-band digital voice repeater pairs across the U.S. Just like existing band plans, the local coordinating bodies have their own approach to assigning frequencies.

Repeater Usage

Let's take a step back from the detailed arguments around Part 97 and examine the situation with a broader view. The fundamental issue is how do we make room for new technologies when they become available. The next question is how effectively are we using the frequency spectrum today. This is the sticky question that we sometimes don't really want to ask. Program your 2 -meter rig to scan across the FM portion of the band and check the level of activity. In most areas of the country it is very quiet. There are many very capable repeater systems, but no one is talking on them. At the same time, more requests are coming in from new groups that want to put a repeater on the air.

Some hams suggest that we must free up some of the "old technology" repeater pairs to make room for newer technologies. An attractive target is to reassign pairs that are not actually being used. These so-called "paper repeaters" are coordinated but (for whatever reason) are not on the air. Most coordinating bodies allow a reasonable time to deal with equipment failures and other unexpected events that can take down a system. At some point, if the repeater isn't really operational the coordination should be pulled.

The much tougher move is to take some of those "under-utilized" repeaters off the air. If no one is talking on them, how hard can it be to shut them down? This is the proverbial can of worms, since it takes us into the business of judging the value of a repeater and how it is used. Is an ARES/RACES repeater that sits idle most of the time and becomes active mostly at net time a good use of spectrum? How do you compare that to the machine that

has "Joe and Charlie" rag-chewing on it all day? Is the actual transmit time on a repeater a good measure of its utility? Or maybe a repeater should be judged by the number of users that support it (and how do you reliably measure that?). There are lots of questions but few answers.

This is a slippery slope that frequency-coordinating bodies don't want to traverse. The reality seems to be that a functioning repeater that is consistently on the air and meeting technical standards will keep its coordination. The end result is that the old technology remains entrenched and the newer technology has to work to find a home in the spectrum. The irony is that adopting narrow-band technology such as D-Star can increase the number of available channels, opening up more repeater and simplex space. The challenge is getting there.

Beyond 2 Meters

Two meters seems to be the band everyone wants to be on, perhaps for good reason. The signals tend to propagate quite well, penetrating buildings reasonably well and diffracting around corners, too. The wavelength makes the physical size of antennas convenient. Quarter-wave verticals can be mounted on the roof of a car and still be garage compatible. High-gain Yagis can be built with 12-foot booms and lightweight masts. FM transceivers are amazingly affordable for the band, with 50-watt, fully-synthesized rigs with all the bells and whistles priced at less than $150. There is much to like about 2 meters.

On the other hand, we might be better off looking beyond 2 meters, especially for the early deployment of D-Star systems. In most areas of the country, a slice of the 70-cm band can be carved out for digital voice usage. Most of the hams interested in D-Star are in the *early adopter* category. These are the guys who are the first ones on the block to try out something. Price is not usually their primary concern. (If it was, they would be holding fast to their existing 2-meter FM rigs.)

Recommendations

I've tried to represent the situation in a balanced way, including conflicting points of view from many sides. I do have some specific recommendations to share. These do not represent the position of *CQ VHF* or anyone else.

- Work with your local frequency coordinating body to develop a plan that works in your area. The last thing we should do with D-Star (or any other new technology) is deploy it randomly across the VHF/UHF bands.
- Consider deploying new technology such as D-Star on one of the less used bands (i.e., not 2 meters).
- If you or your group has a repeater that is off the air, either get it fixed or return the frequency pair for reassignment.
- If you or your repeater group operates one of those lightly used repeaters, consider whether that is a good use of that frequency spectrum. What is the purpose of that repeater and why is it lightly used?
- Consider whether you or your repeater group could lead the way on adopting narrow-band digital technology by converting an analog pair over to narrow-band digital.

These are my thoughts. Please let me know what ideas you have.

Tnx and 73

Thanks for taking the time to read another one of my columns on the "utility mode." I always enjoy hearing from readers, so drop me an e-mail at <bob@k0nr.com> or stop by my blog at <http://www.k0nr.com/blog>.

73, Bob KØNR

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Southeastern Repeater Assn.: <http:// www.sera.org>.

Illinois Repeater Assn.: <http://www.ilra. net>

Texas VHF-FM Society: <http://www. txvhffm.org>.

Two-Meter Area Spectrum Management Association: <http://www.tasma.org>.

ALABAMA D★STAR

D-STAR in the Southeastern U.S.

In the aftermath of Hurricane Katrina, the need for reliable VHF-plus communications was made painfully clear. W4OZK discusses why and how D-STAR is being used throughout Alabama to fill that need and how Alabama's network can be used as a model for the rest of the country.

By Greg Sarratt,* W4OZK

What is this D-STAR technology that everyone is talking about? D-STAR stands for Digital Smart Technology for Amateur Radio. Developed in Japan, D-STAR is now accepted and growing like wildfire in the United States. In a nut shell, D-STAR is a three band, fully digital repeater system that can pass digital voice and digital data.

A nationwide network of 52 D-STAR systems exists, enabling amateurs to make a connection with one another, whether locally or in another city via the internet. These networked systems are not dependent on one another, so if any single or several systems go down, the rest of the network continues to work.

D-STAR's Pioneering Growth

Pioneering this D-STAR technology is the southeastern U.S., and Alabama leads the charge. In 2001 a couple of Alabama hams started investigating an previously unknown technology called D-STAR, developed a plan, and began implementing this new digital technology. In 2006–2007 Alabama has advanced this technology with nationwide training, seminars, users meetings, and 12 operational systems throughout the state.

The 12 Alabama digital repeater systems include over 31 digital repeaters and 10 high-speed data modules. In addition, there are more systems on the drawing board. A variety of individual clubs,

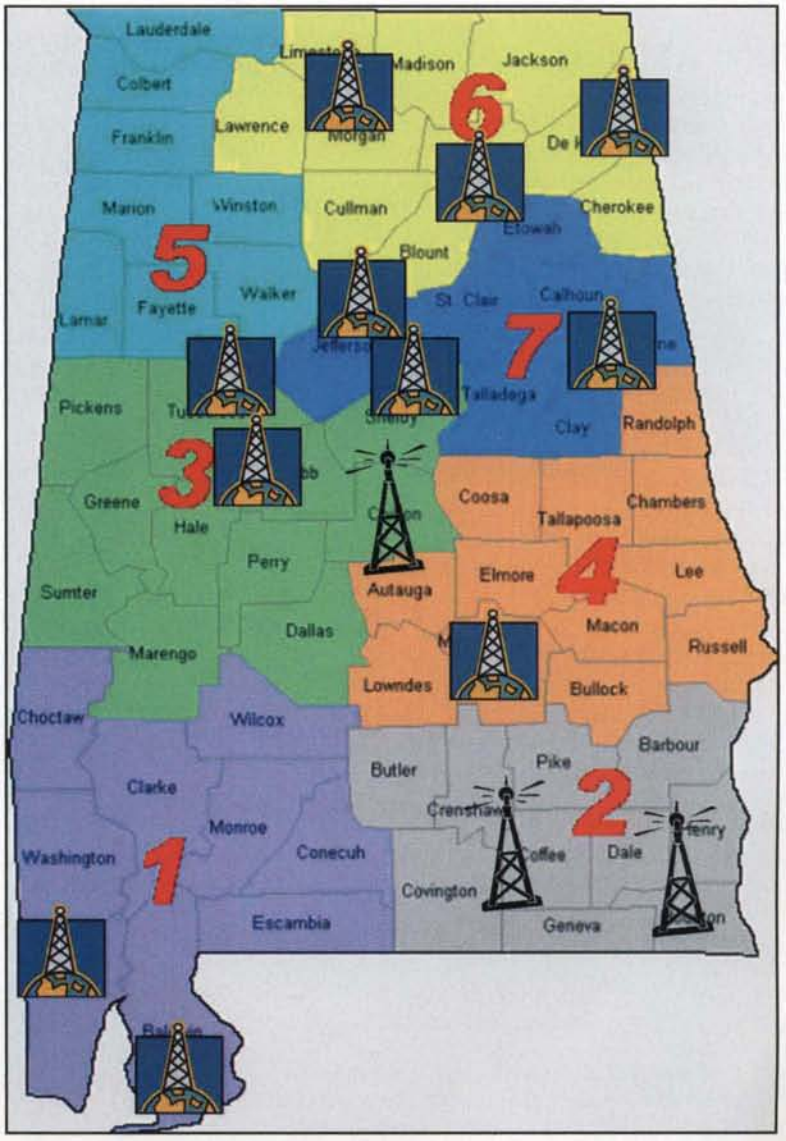

Figure 1. The Alabama Emergency Management Agency districts are in red, the active D-STAR system installations are in the blue boxes, and systems that are in the works are depicted by the black towers.

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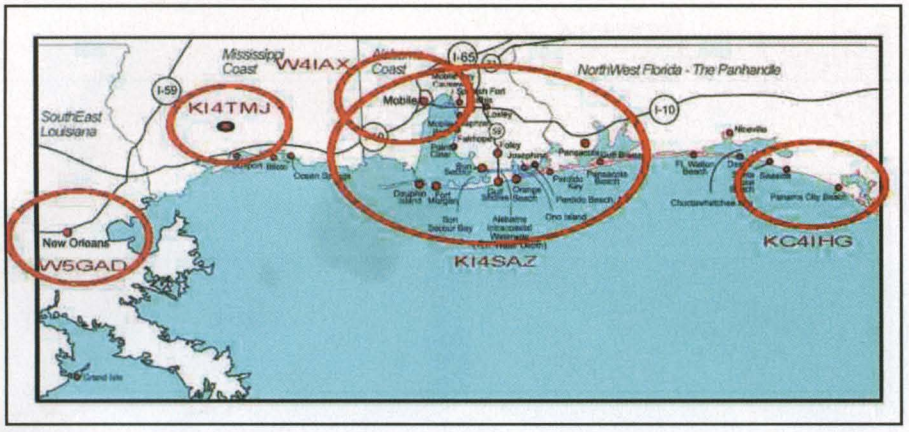

Figure 2. A goal and part of Alabama's 12 repeater systems is to help rebuild the communications infrastructure of the disaster-stricken Gulf Coast area.

groups, and amateurs built, own, and experiment with these systems. Figure 1 shows the Alabama EMA districts in red, the active D-STAR system installations in the blue boxes, and systems that are in the works are depicted by the black towers.

Alabama has developed a multi-point approach to implementing this new technology within amateur radio. Our statewide effort: Bring new digital technologies to amateur radio, enhance emergency communications capabilities, club project opportunities, upgrade existing repeaters, education, and plain old fun.

D-STAR has been the "star of the show" for many southeastern hamfests this year. The D-STAR activities at the 2007 ARRL National Convention, Huntsville Hamfest, were exciting and truly awesome. Amateurs from across the nation and some from outside the U.S. attended the users group meeting. Relationships were built, friendships renewed, and experiences, stories, and ideas exchanged.

The public service dedication of southeastern amateur radio is just one factor that drives amateurs to review and implement new technologies. Amateur radio's customers are asking for more digital data and large amounts of it. Forms, long lists of equipment, and resource needs are the norm. D-STAR is one digital method that will help amateurs provide better service.

Amateur radio operators working with radio and emergency organizations, the Alabama Section of the American Radio Relay League (ARRL), and the Southern Baptist Disaster Relief Group have together launched a D-STAR technology project. This is an aggressive project that utilizes D-STAR as part of the Disaster Relief package. Internet access, digital data, automatic ID, and position coordinates are just a few of the enhanced capabilities the Amateur Radio Emergency Services provides in disaster relief ops.

A strong partnership has formed within these organizations. They plan to use digital data to transfer forms, charts, and pictures to support served agencies during emergencies. This partnership works well and shares people, equipment, resources, training, and exercises. During actual disasters, these pre-established relationships pay quick dividends and efficient communications are provided for public service.

Another goal and part of Alabama's 12 repeater systems is to help rebuild communications infrastructure of the disaster-stricken Gulf Coast. Alabama has an active role in the Louisiana and Mississippi Gulf Coast systems (Figure 2) and provided assistance to other surrounding states. To date, four hardened systems have been built from New Orleans, Louisiana to Magnolia Springs, Alabama. Go to <http://www. arrlal.org/Alabama_link.htm> and <http://www.dstarusers.org> for more information.

Alabama will continue to be a progressive leader in amateur radio technologies. Whether you like old technology, new technology, or something in between, get on board and make it the best it can be!

By Kent Britain,* WA5VJB

ANTENNAS

Connecting the Radio to the Sky

D-Star Antennas

As many of us know, the VHF/UHF repeater slots are pretty full in the metropolitan areas. At the same time, it takes a lot of local activity to support new technologies. The end result is that many of the new D-Star repeater systems are showing up on 1200 MHz. This month we will cover the three antennas designed for these new D-Star systems (photo A). Keep this quiet, but they also work on AMSAT L-band, 1200-MHz ATV, and SSB, and the little one makes one heck of a quick dish feed.

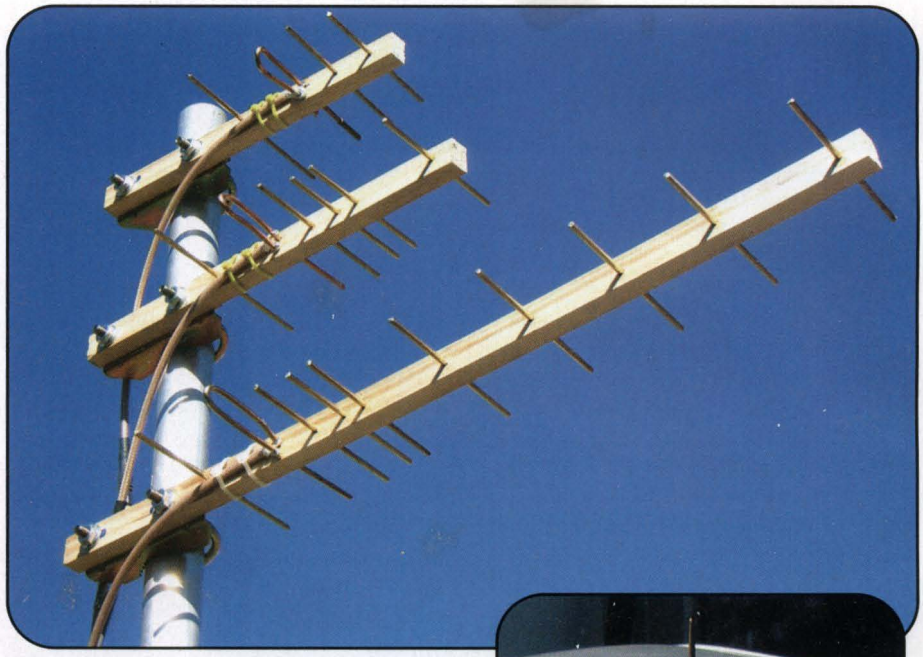

Photo A. D-Star 1200-MHz antennas.

Mobile Antenna

Photo B is a simple 1200-MHz mobile antenna. Have you priced any of the commercial 1200-MHz mobile antennas yet? Have you gotten over the shock? The one shown in photo B will cost you an old mag-mount antenna and a length of stiff wire. Vintage 800-MHz cell-phone antennas work well here as a source of parts. This is a simple vertical collinear antenna with about 5 to 6 dBi gain.

Start with about 16 inches of stiff wire. I used 1/16-inch bronze welding rod, but an old stainless-steel whip can be used—if you can bend it!

You do not want to use a magnetic mount that contains any loading or matching networks in the base. Just use something that is a plain magnet. Also, it doesn't have to be a magnetic mount; it can be a threaded new Motorola type antenna mount, but watch the total height.

After you form the whip per figure 1, mount it such that the bottom of the phasing section is 3.5 inches above the ground plane. I'll bet you never had to allow for the thickness of your mount or magnet before. Welcome to 1200 MHz!

Tweaking SWR

Built per the dimensions, SWR should be well under 2:1. However, if you are one of those people who can't stand any SWRs crawling around on your antenna, and you can measure SWR (we tend to call it return loss on these frequencies), Do your tuning by expanding and compressing the coil. The coil is really a delay line that keeps the top and bottom sections of the antenna in phase. It's not a loading coil like you would see on HF.

The one place to be very careful is in the choice of your magnetic mount. Many CB mounts have tuning caps in their base and stand too high. You want a mount with a pretty low profile. You also want your coax long enough to do its job and not much longer. Small-diameter coax has a lot more loss at these frequencies than it does at 2 meters or 440 MHz. So again, just long enough to do the job is best.

Simple Yagis

If you are a fair distance from the repeater, a little gain and getting the antenna up a bit higher can help a lot. These Yagi antennas are part of a family of simple and inexpensive antennas we affectionally call "Cheap Yagis." The antennas are designed a bit differently. We start with the driven element, which has about a 150-ohm impedance. As other elements are brought close to the driven element, they load down the driven ele-

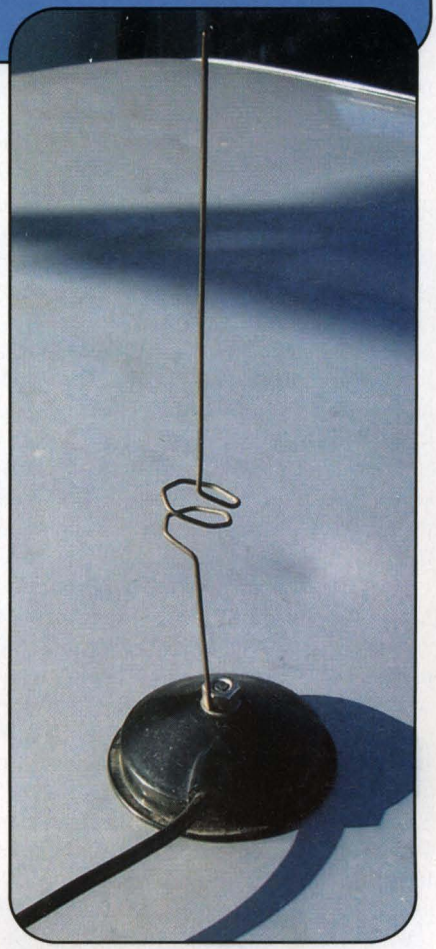

Photo B. A 1200-MHz mobile antenna.

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ment. By spacing the other elements at just the right distance, we end up with a 50-ohm match. You don't need any baluns, chokes, matching stubs, or gamma rods. Just build and go.

If you were careful in measuring the boom and elements, the SWR should be well under 1.5:1. In figure 2 we have the return loss, or SWR plot, of the 4-element Yagi (photo C). The –10 dB line is about a 2:1 SWR. The –20 dB line is a 1.1:1 SWR.

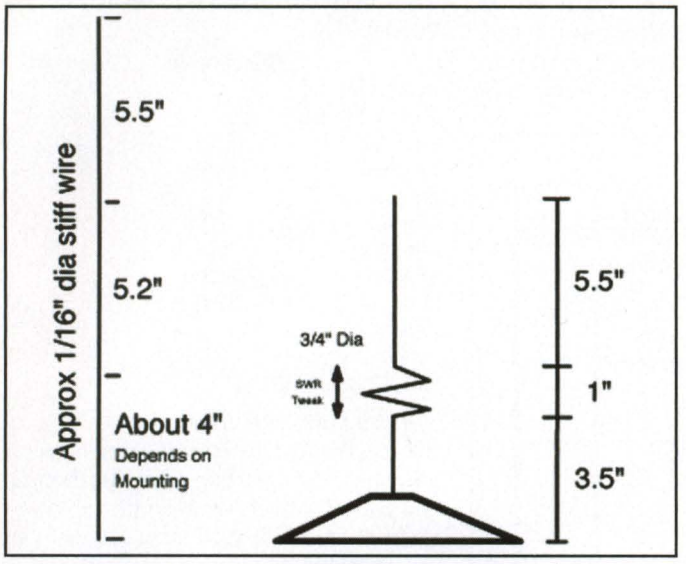

Figure 1. Dimensions for the 1200-MHz vertical.

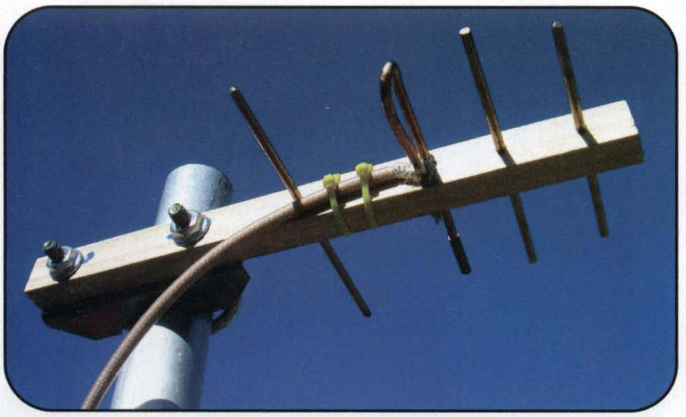

Photo C. The 4-element 1200-MHz Yagi.

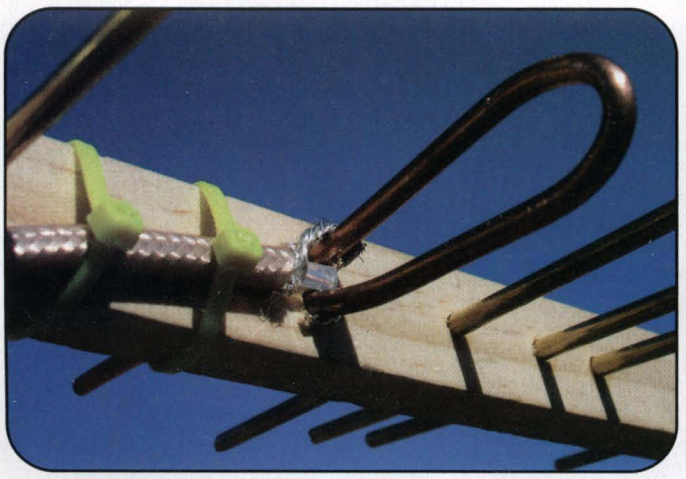

Photo D. Driven element and coax.

The wood should not be more than 3/4 inch thick, but just about any kind of wood can be used. I used 1/2-inch by 3/4-inch wood, but 1/2-inch by 1/2-inch or even round dowel can be used. However, square wood is much easier to drill!

At 1200 MHz the wood does have some effect on the element—not much, but not zero effect either. For the elements you can use almost any 1/8-inch diameter material. I usually use bronze welding rod, but #10 copper wire, hobby tubing, or even aluminum ground-rod wire works. However, something such as brass or copper is good for the driven element so you can more easily solder the coax to the driven element.

The driven element (photo D) is similar to a folded dipole antenna, but it is looped on only one side. The very center of a Yagi element is a voltage null, so you can solder the coax shield directly to the center of the driven element. In this case it's near the center, but close enough. The tip of the coax goes to near the tip of the J in the driven element.

All three versions use the driven element shown in figure 3. For two of the antennas I used #10 copper wire, and for the third I just bent one of the pieces of bronze welding rod into the J shape.

These antennas work well when attached to a rafter in the attic of a house. If you want to mount it outside for a few years, a little weather proofing is in order. Spar varnish seems to work best, with spray epoxy paint coming in second. I like to use a light gray color, which helps them blend in with the surroundings. You can even use latex house paint and camouflage it using the same color as your house. Water does tend to wick back down the coax braid, so a good coating of RTV-type sealant, or even plenty of paint, helps to waterproof the coax.

4 Elements

This is the smallest of the designs. The antenna has good gain, about 8 dBi. It has good SWR from 1240 MHz to 1300 MHz, so you can use it with 1200-MHz ATV, AMSAT, SSB, and D-Star applications. It's also not a bad dish feed.

	Spacing (in.)	Length (in.)
Reflector	0	4.5
Driven element	1.75	see fig. 3
Director 1	2.75	4.0
Director 2	3.75	3.5

6 Elements

This one is a little bit longer and has a bit more gain (photo E). With the 6-element version the gain peaks at about 10 dBi

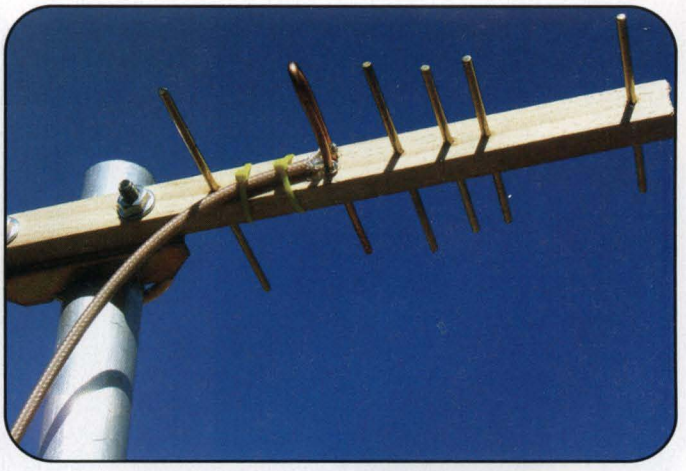

Photo E. The 6-element 1200-MHz Yagi.

at the upper portion of the band, with the cleanest pattern around 1280 MHz. But again, the antenna is usable over the entire 1240-MHz to 1300-MHz band.

	Spacing (in.)	Length (in.)
Reflector	0	4.5
Driven Element	1.75	see fig. 3
Director 1	2.75	4.0
Director 2	3.5	3.75
Director 3	4.0	3.75
Director 4	6.0	3.75

10 Elements

Now we have the "big gun" among these small antennas (photo F). The 10 element's gain also peaks in the upper part of the band at nearly 13 dBi. The cleanest pattern is still 1270–1280 MHz, and again the antenna is usable over the entire 1240–1300 MHz ham band. Designing the antenna for such a wide bandwidth does cost nearly 1 dB of gain, but with a wide frequency range, the antenna is far more forgiving if the construction is a bit sloppy. Thus, many Yagi designs give dimensions such as 3.6913 inches. It is not an accident that most dimensions are either even inches or to the nearest 1/4 inch. You don't need a micrometer to build these antennas, as for some designs out there. A yard stick will do just fine.

	Spacing (in.)	Length (in.)
Reflector	0	4.5
Driven Element	1.75	see fig. 3
Director 1	2.75	4.0
Director 2	3.5	3.75
Director 3	4.0	3.75
Director 4	6.0	3.75
Director 5	8.0	3.75
Director 6	10.0	3.75
Director 7	12.0	3.75
Director 8	14.5	3.5

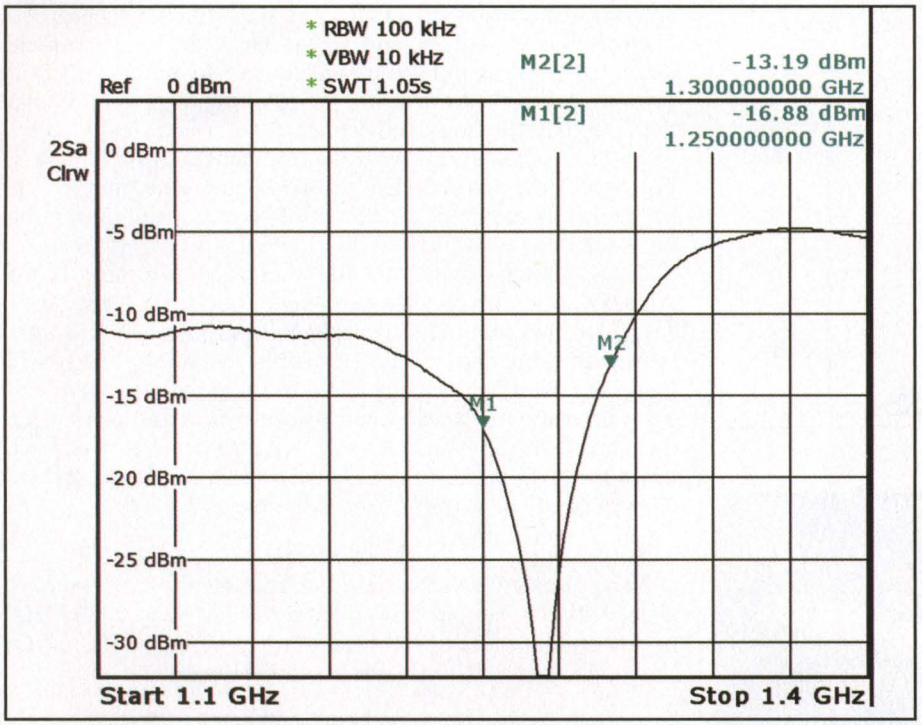

Figure 2. Return loss or SWR plot of the 4-element Yagi.

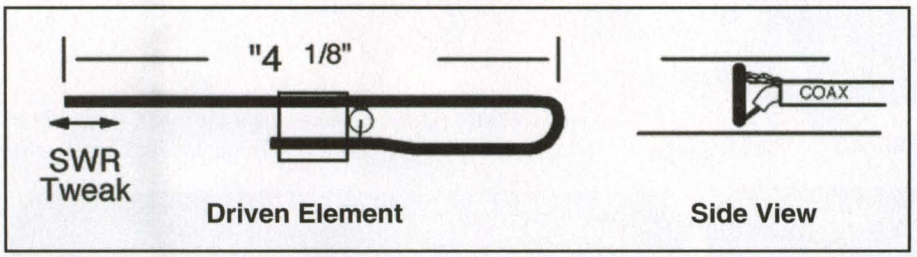

Figure 3. Dimensions for the driven element used on all versions of the Yagis.

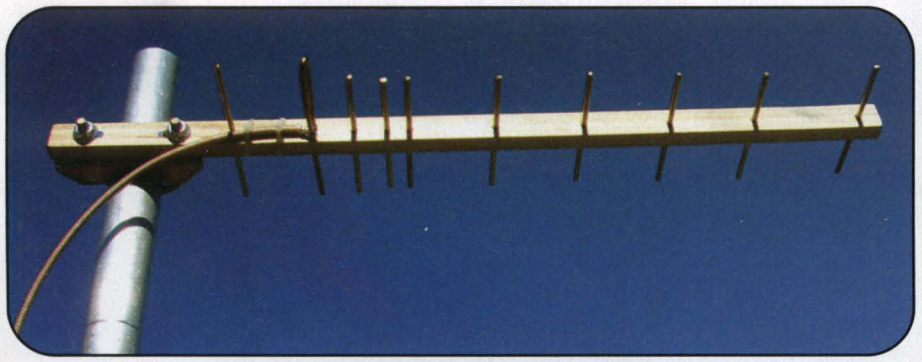

Photo F. The 10-element 1200-MHz Yagi.

Conclusion

For my next column I am working on the mechanical aspects of some 6-meter antennas. As a parting thought, though, can you tell what is wrong with the antenna in photo G? It took me a few days to figure it out, but gain at the horizon is very poor. We will cover why next time.

As always, we welcome your technical questions and suggestions for future topics. Just drop me a line at <wa5vjb@cq-vhf.com>, or you can visit my website, <www.wa5vjb.com> for more antenna articles, perhaps download some vintage VHF newsletters, and coming soon, view a virtual museum of Tecraft VHF converters and radios. 73, Kent, WA5VJB

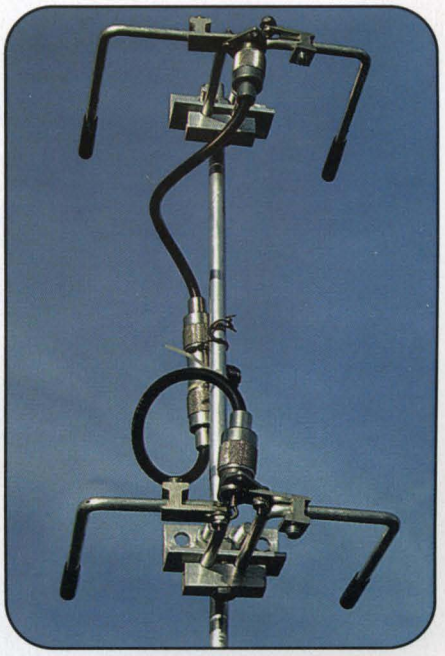

Photo G. What's wrong with this antenna? We'll explore this more next time.

CQ's 6 Meter and Satellite WAZ Awards

(As of January 1, 2008)

By Floyd Gerald,* N5FG, CQ WAZ Award Manager

6 Meter Worked All Zones

No.	Callsign	Zones needed to have all 40 confirmed
1	N4CH	16,17,18,19,20,21,22,23,24,25,26,28,29,34,39
2	N4MM	17,18,19,21,22,23,24,26.28.29,34
3	JI1CQA	2,18,34,40
4	K5UR	2,16,17,18,19,21,22,23,24,26,27,28,29,34,39
5	EH7KW	1,2,6,18,19,23
6	K6EID	17,18,19,21,22,23,24,26,28,29,34,39
7	KØFF	16,17,18,19,20,21,22,23,24,26,27,28,29,34
8	JF1IRW	2,40
9	K2ZD	2,16,17,18,19,21,22,23,24,26, 28,29,34
10	W4VHF	2,16,17,18,19,21,22,23,24,25,26,28,29,34,39
11	GØLCS	1,2,3,6,7,12,18,19,22,23,25,28,30,31,32
12	JR2AUE	2,18,34,40
13	K2MUB	16,17,18,19,21,22,23,24,26,28,29,34
14	AE4RO	16,17,18,19,21,22,23,24,26,28,29,34,37
15	DL3DXX	18,19,23,31,32
16	W5OZI	2,16,17,18,19,20,21,22,23,24,26,28,34,39,40
17	WA6PEV	3,4,16,17,18,19,20,21,22,23,24,26,29,34,39
18	9A8A	1,2,3,6,7,10,12,18,19,23,31
19	9A3JI	1,2,3,4,6,7,10,12,18,19,23,26,29,31,32
20	SP5EWY	1,2,3,4,6,9,10,12,18,19,23,26,31,32
21	W8PAT	16,17,18,19,20,21,22,23,24,26,28,29,30,34,39
22	K4CKS	16,17,18,19,21,22,23,24,26,28,29,34,36,39
23	HB9RUZ	1,2,3,6,7,9,10,18,19,23,31,32
24	JA3IW	2,5,18,34,40
25	IK1GPG	1,2,3,6,10,12,18,19,23,32
26	W1AIM	16,17,18,19,20,21,22,23,24,26,28,29,30,34
27	K1LPS	16,17,18,19,21,22,23,24,26,27,28,29,30,34,37
28	W3NZL	17,18,19,21,22,23,24,26,27,28,29,34
29	K1AE	2,16,17,18,19,21,22,23,24,25,26,28,29,30,34,36
30	IW9CER	1,2,6,18,19,23,26,29,32
31	IT9IPQ	1,2,3,6,18,19,23,26,29,32
32	G4BWP	1,2,3,6,12,18,19,22,23,24,30,31,32
33	LZ2CC	1
34	K6MIO/KH6	16,17,18,19,23,26,34,35,37,40
35	K3KYR	17,18,19,21,22,23,24,25,26,28,29,30,34
36	YV1DIG	1,2,17,18,19,21,23,24,26,27,29,34,40
37	KØAZ	16,17,18,19,21,22,23,24,26,28,29,34,39
38	WB8XX	17,18,19,21,22,23,24,26,28,29,34,37,39
39	K1MS	2,17,18,19,21,22,23,24,25,26,28,29,30,34
40	ES2RJ	1,2,3,10,12,13,19,23,32,39
41	NW5E	17,18,19,21,22,23,24,26,27,28,29,30,34,37,39
42	ON4AOI	1,18,19,23,32
43	N3DB	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
44	K4ZOO	2,16,17,18,19,21,22,23,24,25,26,27,28,29,34
45	G3VOF	1,3,12,18,19,23,28,29,31,32
46	ES2WX	1,2,3,10,12,13,19,31,32,39
47	IW2CAM	1,2,3,6,9,10,12,18,19,22,23,27,28,29,32
48	OE4WHG	1,2,3,6,7,10,12,13,18,19,23,28,32,40
49	TI5KD	2,17,18,19,21,22,23,26,27,34,35,37,38,39
50	W9RPM	2,17,18,19,21,22,23,24,26,29,34,37
51	N8KOL	17,18,19,21,22,23,24,26,28,29,30,34,35,39
52	K2YOF	17,18,19,21,22,23,24,25,26,28,29,30,32,34
53	WA1ECF	17,18,19,21,23,24,25,26,27,28,29,30,34,36
54	W4TJ	17,18,19,21,22,23,24,25,26,27,28,29,34,39
55	JM1SZY	2,18,34,40
56	SM6FHZ	1,2,3,6,12,18,19,23,31,32
57	N6KK	15,16,17,18,19,20,21,22,23,24,34,35,37,38,40
58	NH7RO	1,2,17,18,19,21,22,23,28,34,35,37,38,39,40
59	OK1MP	1,2,3,10,13,18,19,23,28,32
60	W9JUV	2,17,18,19,21,22,23,24,26,28,29,30,34
61	K9AB	2,16,17,18,19,21,22,23,24,26,28,29,30,34
62	W2MPK	2,12,17,18,19,21,22,23,24,26,28,29,30,34,36
63	K3XA	17,18,19,21,22,23,24,25,26,27,28,29,30,34,36
64	KB4CRT	2,17,18,19,21,22,23,24,26,28,29,34,36,37,39
65	JH7IFR	2,5,9,10,18,23,34,36,38,40
66	K0SQ	16,17,18,19,20,21,22,23,24,26,28,29,34
67	W3TC	17,18,19,21,22,23,24,26,28,29,30,34
68	IKØPEA	1,2,3,6,7,10,18,19,22,23,26,28,29,31,32
69	W4UDH	16,17,18,19,21,22,23,24,26,27,28,29,30,34,39
70	VR2XMT	2,5,6,9,18,23,40
71	EH9IB	1,2,3,6,10,17,18,19,23,27,28
72	K4MQG	17,18,19,21,22,23,24,25,26,28,29,30,34,39
73	JF6EZY	2,4,5,6,9,19,34,35,36,40
74	VE1YX	17,18,19,23,24,26,28,29,30,34
75	OK1VBN	1,2,3,6,7,10,12,18,19,22,23,24,32,34
76	UT7QF	1,2,3,6,10,12,13,19,24,26,30,31
77	K5NA	16,17,18,19,21,22,23,24,26,28,29,33,37,39
78	I4EAT	1,2,6,10,18,19,23,32
79	W3BTX	17,18,19,22,23,26,34,37,38
80	JH1HHC	2,5,7,9,18,34,35,37,40.
81	PY2RO	1,2,17,18,19,21,22,23,26,28,29,30,38,39,40
82	W4UM	18,19,21,22,23,24,26,27,28,29,34,37,39
83	I5KG	1,2,3,6,10,18,19,23,27,29,32

Satellite Worked All Zones

No.	Callsign	Issue date	Zones Needed to have all 40 confirmed
1	KL7GRF	8 Mar. 93	None
2	VE6LQ	31 Mar. 93	None
3	KD6PY	1 June 93	None
4	OH5LK	23 June 93	None
5	AA6PJ	21 July 93	None
6	K7HDK	9 Sept. 93	None
7	W1NU	13 Oct. 93	None
8	DC8TS	29 Oct. 93	None
9	DG2SBW	12 Jan. 94	None
10	N4SU	20 Jan. 94	None
11	PAØAND	17 Feb. 94	None
12	VE3NPC	16 Mar. 94	None
13	WB4MLE	31 Mar. 94	None
14	OE3JIS	28 Feb. 95	None
15	JA1BLC	10 Apr. 97	None
16	F5ETM	30 Oct. 97	None
17	KE4SCY	15 Apr. 01	10,18,19,22,23, 24,26,27,28, 29,34,35,37,39
18	N6KK	15 Dec. 02	None
19	DL2AYK	7 May 03	2,10,19,29,34
20	N1HOQ	31 Jan. 04	10,13,18,19,23, 24,26,27,28,29, 33,34,36,37,39
21	AA6NP	12 Feb. 04	None
22	9V1XE	14 Aug. 04	2,5,7,8,9,10,12,13, 23,34,35,36,37,40
23	VR2XMT	01 May 06	2,5,8,9,10,11,12,13,23,34,40

CQ offers the Satellite Work All Zones award for stations who confirm a minimum of 25 zones worked via amateur radio satellite. In 2001 we "lowered the bar" from the original 40 zone requirement to encourage participation in this very difficult award. A Satellite WAZ certificate will indicate the number of zones that are confirmed when the applicant first applies for the award.

Endorsement stickers are not offered for this award. However, an embossed, gold seal will be issued to you when you finally confirm that last zone.

Rules and applications for the WAZ program may be obtained by sending a large SAE with two units of postage or an address label and $1.00 to the WAZ Award Manager: Floyd Gerald, N5FG, 17 Green Hollow Rd., Wiggins, MS 39577. The processing fee for all CQ awards is $6.00 for subscribers (please include your most recent *CQ* or *CQ VHF* mailing label or a copy) and $12.00 for nonsubscribers. Please make all checks payable to Floyd Gerald. Applicants sending QSL cards to a CQ Checkpoint or the Award Manager must include return postage. N5FG may also be reached via e-mail: <n5fg@cq-amateur-radio.com>.

**17 Green Hollow Rd., Wiggins, MS 39577; e-mail: <n5fg@cq-amateur-radio.com>*

By John Champa,* K8OCL

HSMM

Communicating Voice, Video, and Data with Amateur Radio

The Hinternet

Protecting HSMM Radio Networks

The 2.4-GHz (13-cm) band presents some unique challenges to HSMM (High Speed Multimedia) radio amateurs. Not only do we share some of the same frequencies (Wireless LAN channels 1 through 6 are within the amateur band), but also we almost always use the same modulation type, IEEE 802.11b/g.

In the years that the former HSMM WG (Working Group) negotiated with the FCC Enforcement Branch via the ARRL's highly experienced attorney, we experimented with many different approaches to avoiding auto-association with Part 15 unlicensed stations. We knew that was one form of communications the FCC did not want to see happen except in the case of an emergency.

What was needed is some effective method of communications isolation or protection called *authentication.* This would immediately identify the Part 15 stations and also immediately restrict them from entering into our Part 97 networks.

First we tried cross polarization. Most Part 15 stations use vertical polarization, so we thought horizontal polarization would provide isolation. That helped somewhat, depending on the situation. However, not all Part 15 stations use vertical polarization, and the multi-path effect causes many polarization shifts that negate the expected isolation.

Then we tried moving out of the WLAN channels range but still within the amateur radio band. Some of our WG called this Channel Zero Experiments. Modification of the repeater (access point (AP)/wireless router) frequency and the modification of the client transceiver (PC card) were both required. However, we were dismayed to find that this wasn't enough of a frequency change. Most standard WiFi PC cards are so broad-banded and unselective that they would auto-associate with Channel 0 gear anyway!

Many other approaches to keeping Part 15 and Part 97 traffic completely separated were investigated. In the end it was concluded that they all added significant overhead to the fledging networks. Either they cost too much, added significant network complexity, or caused a greatly enhance administrative burden, or all of these, thus crippling radio experimentation by Part 97 stations.

The WG finally came to the conclusion that the very methods built into the modulation protocols themselves (WEP, WPA) held the solution. Yes, these are primarily encryption methods, but they also very efficiently and cost effectively provide a poor-man's authentication method. However, the intent is not to obscure the meaning of the transmissions, only to protect the network. With your callsign always in the clear (service set identifier, or SSID), the encryption published and standardized, plus the key recorded in your station logbook, this should be evident to all.

As Les Rayburn, N1LF, Shelby County, Alabama ARES EC recently wrote to me regarding this struggle within:

> Like many, I've sat on the sidelines trying to make sense of this hot-button issue: Encryption, especially as it applies to HSMM radio, seems to attract both the best of our technical minds, and the worst of our "barracks lawyers." As an amateur whose primary interest is in emergency communications, I can tell you that security is something that served agencies are concerned about—especially when you're dealing with hospitals and at the federal level, where the Privacy Act seems to creep into almost any discussion.
>
> While we can, and undoubtedly will continue to debate both the technical and legal questions, it's clear that what is really needed is for the FCC to clarify the issue. It might even make sense for us to pursue an exception to the rule that applies to transmissions during emergencies. While I understand the logic of not wanting to see the Amateur Service turned into a common carrier for third-party traffic, it makes little sense for millions of Part 15 users to have no restrictions on encryption, while we as Part 97 users cannot provide even basic levels of security when needed to satisfy our served agencies needs.
>
> As we move into the digital age of amateur radio, our ability to provide backup connections to e-mail and the web will become critical to our role in EMCOMM. We offer a service that is independent of local infrastructure, more survivable than other forms of communication, and more adaptable. All of that may become moot if we can't also offer a service that provides served agencies with the ability to protect information that is transmitted. The other factor is that public service agencies are moving toward P25, and with those moves, we'll likely see more and more agencies opting to encrypt their voice transmissions as well. Once an agency has made the internal decision that OPSEC is important to them, you'll find it very difficult to convince them that amateur radio is an acceptable alternative.
>
> Suggesting alternatives to encryption such as the use of APRS, Winlink 2K, SSB, PSK-31, or other modes provides only the illusion of operational security. Most of these issues are being driven by lawyers, and in a legal sense, these modes are not encrypted or secure. By suggesting that they are, you actually may increase liability for your own group. Certainly these can all provide a level of protection against interception by casual listeners, but I'd be careful of overstating that ability. All it takes is one incident where information that was believed to be secure is intercepted and used for some nefarious purpose. Then all of amateur radio may be tainted by the experience.
>
> For these reasons, and more, we need our leadership to address these concerns with the FCC, and seek rule changes where appropriate to ensure our ability to serve the common good. For those who say we need to avoid the "customer service" mentality, I can understand that position. But the political reality is that public service is the best justification that amateur radio has for its use of the spectrum. You'll never convince a lawmaker that working some rare DX justifies a bigger 60 meter allocation, but you might make the case that we need that piece of spectrum to ensure round-the-clock HF backup links during a disaster.

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Instead of debating the topic endlessly, I'd encourage amateurs to do something more constructive. Notify your leadership within the ARRL and let them know that this issue is of concern to you. I've communicated my concerns to my section leader, division director, and also to Dennis Dura, K2DCD, who was recently hired as the League's emergency manager. I'm encouraged by his hiring, and also by more amateurs with real EMCOMM experience taking positions of leadership within the League. I think that these important issues may begin to get more of the attention that they deserve. But like any democratic organization, it's imperative that members let their leaders know what issues concern them.

Software Configuration Suggestions

The AP/wireless-router host software is provided with an SSID (service set identifier) which many Part 15 stations turn off supposedly for somewhat higher security. However, radio amateurs should leave it ON. Enter your callsign as the SSID and use it for the station identification. It constantly broadcasts your call in the clear, thus providing automatic and constant station identification.

To be as non-interfering with other services as possible, we need to also look at channel selection. The channels provided under Part 15 are only 5 MHz. However, the 802.11b/g bandwidth is approximately 20 MHz wide. This results in considerable frequency overlap. As a consequence of this, there are only three totally non-overlapping channels: 1, 6, and 11. Channel 11 is outside the amateur Rradio band, so we will focus our discussion only on channels 1 through 6.

Security: It is recommended that you use WEP with a simple key. Remember our purpose here is not to provide encryption, but to enable a simple, cost-effective, and readily available means of authentication. We are not intending to *obscure* the meaning. We are trying to protect the link from Part 15 auto-association or connection—an important distinction! Regardless of what method or level of HSMM radio network protection you decide to use (WEP, WPA, etc.), it should be recorded in your station logbook along with its specific key.

SSID: Again, enabled and with your callsign. It is beaconed periodically for station ID and is always in the clear.

Channel Selection: After you have completed a site survey of 802.11 activity in your area, you will be in a much better position to select an appropriate channel for your HSMM radio link. In the interim, here are some general guidelines: Avoid channel 6. It is the most common manufacturers' default channel setting, and 90 percent or more of your neighbors will be using it for their household wireless LAN. Channel 1 is used by most of the remaining manufacturers as their default channel, so that probably should also be avoided. The result is most radio amateurs use channel 3 or 4, depending on whether there is a WISP (wireless internet service provider) oper-

WRT54GL

Linksys released the WRT54GL in 2005 to support third-party firmware based on Linux, after the original WRT54G line was switched from Linux to VxWorks, starting with version 5.

Version	CPU speed	RAM	Flash memory	S/N Prefix	Notes
1.0	200 MHz	16 MB	4 MB	CL7A	New model line, released after the version 5 WRT54G, which returns to a Linux-based OS as opposed to the VxWorks firmware. The hardware is essentially the same as the WRT54G version 4.0. One alteration is that the internal numbering scheme of the 4-port switch changed in this model, from 1 2 3 4, to 3 2 1 0.
1.1	200 MHz	16 MB	4 MB	CL7B CL7C	In June 20, 2006, this version was shipping with firmware revision 4.30.7. This pre-loaded firmware allows the user to upload a 4 MB firmware image, whereas the pre-loaded firmware on version 1.0 limited the image to 3MB. Firmware version 4.30.11 is now available for both hardware versions. Fully supported by Tomato, openwrt, and DD-WRT.
1.1	200 MHz	32 MB	8 MB	CO61	This is a T-Mobile Special Edition. It is a WRT-54GL (renamed WRT54G-TM). Uses BCM5352EKPBG Chipset and Linux OS. Fully supported by Tomato, openwrt, and DD-WRT. It requires a jtag cable to flash a WRT54GL 1.1 cfe to it, as its stock cfe will reject non T-Mobile/Linksys firmware images. Build the cfe from scratch with your routers' Mac address using "skynet repair kit." After flashing the cfe to it, you can download the Linksys stock firmware for a WRT54GL 1.0 and then use the Linksys web page update tool to flash the third-party firmware onto it. The IP address will go from 192.168.0.1(t-mobile firmware) to 192.168.1.1(WSRT54GW 1.0-1.1 firmware).

ating in their area or not. In that situation, some tactful negotiations may be needed to peacefully co-exist. No, it is not a perfect solution, but at least it is a good faith effort to keep most of your possibly stronger RF signal out of anybody's home or business WLAN.

HSMM Area Surveys

Area or site surveys were mentioned in earlier columns, but we can't put enough emphasis on the need for these surveys *before* you start operating. Exactly how should these be conducted?

Both licensed amateurs (FCC Part 97 Regulations) and unlicensed (FCC Part 15 Regulations) stations use the 2.4-GHz band. To be a good neighbor, find out what others are doing in your area before designing your club's HSMM radio network or long-range Field Day link. This is easy to do using IEEE 802.11 modulation. Unless it has been disabled, an access point/router is constantly sending out an identification beacon known as its SSID. In HSMM practice this is simply the amateur radio station callsign (and perhaps the local radio club name) entered into the software configuration supplied on the CD that comes with the device.

An area or site survey using appropriate monitoring software, for example the free *NetStumbler* software downloaded and running on your PC (http://www.netstumbler.com/index.php), is recommended prior to starting up any HSMM radio operations. Slew your station's directional antenna through a 360-degree arc, and drive your HSMM mobile station (described earlier) around your local area, but not at the same time (hi). This HSMM area survey will identify and automatically log most other 802.11 station activity in your area. There are many different ways to avoid interference with other users of the band when planning your HSMM radio operating. For example, moving your operating frequency two to three channels away from the other stations is often sufficient to avoid head-on QRM.

Basic HSMM Radio Station

How do you set up an HSMM radio base station? It is really very easy. HSMM radio amateurs can go to any electronics outlet or office-supply store and buy commercial off-the-shelf (COTS) Wireless LAN gear, either IEEE 802.11b (now more or less obsolete and usually sold for very low prices) or IEEE 802.11g. There are also amateur radio suppliers of such equipment such as FAB Corporation (http://www.fab-corp.com).

By far the most popular HSMM radio repeater model in use in amateur radio is the Linksys WRT54GL wireless router. It is a combination unit consisting of a wireless access point (AP) or hub coupled with a router. As with other routers, your host PC laptop connects directly to it using a standard Ethernet cable. If the PC is also connected to the internet, then it may also perform the function of an HSMM radio *gateway*. If further, this PC is loaded with appropriate server software, it may also perform a network server function such as e-mail management.

This popular HSMM radio wireless router is a Linux-based model that supports firmware upgrades to distros such as DD-WRT and Tomato (see this URL for details: <http://www.youtube.com/ watch?v=No_NyW2Ug9o>).

If you select the Linksys WRT54GL as your host computer's device, the following link will help talk you through the setup: <http://www.youtube.com/watch?v=No_NyW2Ug9o>.

When you unpackage the AP/router, disconnect both rubber-duck antennas that come with the unit and put them in your parts box or nearest trash container. To connect an outside antenna or even a small field antenna such as the MFJ-1800, you are going to be become familiar with RP (reverse polarity) connectors. These are connectors that may appear to be, for example, male connectors on the outside. However, a close examination of the interior of the connector will reveal that there is no pin. Instead it will be equipped with a socket. Confusing? Not really. How do you get around this situation so you can connect your coaxial cable for the long run out to the tower, etc.? There are two common approaches: (1) use a TNC RP to female N-series adaptor, or (2) construct or purchase a pigtail adaptor with a TNC RP connector on one end and a female N-series connector on the other end.

However, there are *two* antenna ports (used for *receive* space diversity). Which one do you connect to?

The transmitted signal from the wireless router always goes out the same antenna port, except for some Cisco® models that also have *transmit* space diversity. Some access points will allow you to select which antenna port is used for transmission. When one does not allow such choice, you will need to find some means of detecting which antenna is the transmit antenna port with RF output power present. That is the port for the pigtail/feedline connection to your exterior antenna.

Now you are ready to connect your wireless router to the length of low-loss coaxial cable (often LMR-400, equivalent or better) running to the tower, mast, or roof-mounted directive antenna outside. You now have the host end of the link. This is the most complex part of the link. The far end is much simpler. We will cover that in our next column.

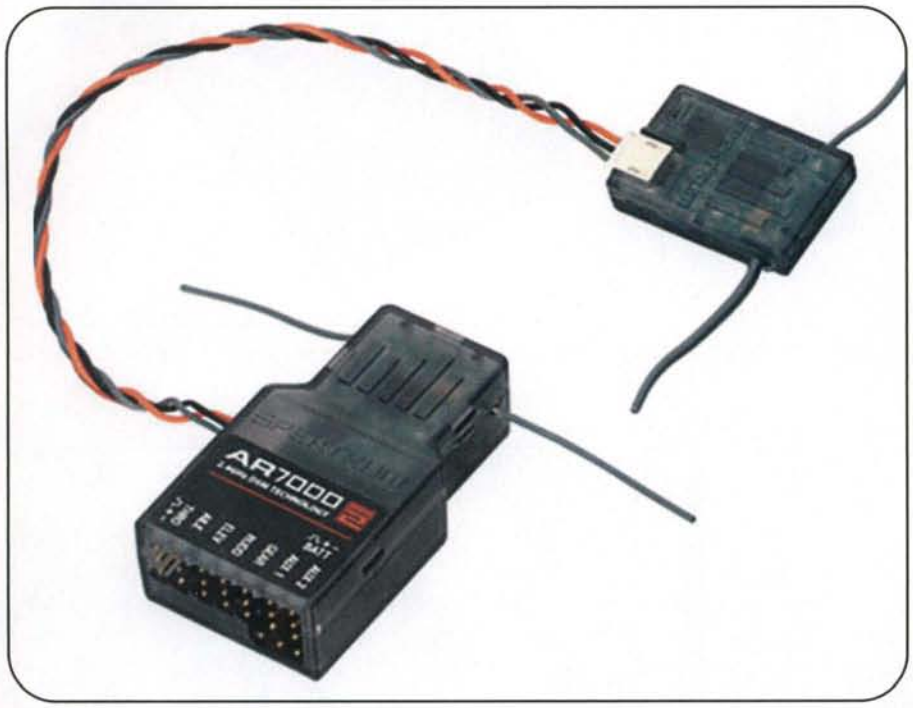
73, John, K8OCL

By Del Schier,* K1UHF

AIRBORNE RADIO

Using Amateur Radio to Control Model Aircraft

Radio Control QSYs to 2.4 GHz



Spektrum 2.4-GHz dual-diversity receiver. Note the tiny dipole wires out of each receiver module.

Futaba transmitter module that converts a Futaba VHF transmitter to 2.4 GHz.

Almost since the beginning of radio control, hams used 50 MHz for RC and it is still used to this day. However, all good things must come to an end. When I started writing this column, I knew that RC radio manufacturers were about to introduce 2.4-GHz spread-spectrum transmitters and receivers, but flying a RC airplane on 6 meters was still the way to go.

The primary advantage of being both a ham and an RC modeler was that you could fly on 50 MHz. The advantage is there is a much lower chance of a channel conflict than on the unlicensed 72-MHz RC band, and of course, it is a huge concern that you have a clear channel to fly RC aircraft; otherwise there are obvious problems.

In a very short time, 2.4-GHz spread-spectrum (SS) RC radios have become available from most of the major manufacturers and a few new, smaller ones. The use of unchannelized spread spectrum allows many radios to operate at the same flying field with no noticeable interference and or worry about channels.

It is interesting that in 1898 Nikola Tesla actually recognized the advantage of a secure spread-spectrum system for radio control and filed a patent for it. Basically, spread spectrum uses a much wider bandwidth than is needed to transmit the necessary information and relies on a unique synchronized and coded protocol of modulation and frequency hopping, so the receiver only recognizes "its" transmitter. SS has to be synchronized, or married, in order for communication to take place. It is possible that two systems could interfere, but that is very unlikely, as even the simple SS system in a cordless phone would have thousands of unique combinations. The recent availability of inexpensive SS systems for RC model airplanes is probably a direct result of the mass-marketed technology used in cordless phones and WiFi Ethernet.

The features and functions of 2.4-GHz RC equipment are basically the same as VHF equipment, except that the antennas are smaller and easier to deal with. The transmitter can be your older VHF transmitter with a new 2.4-GHz transmitter module plugged in the back, or you can

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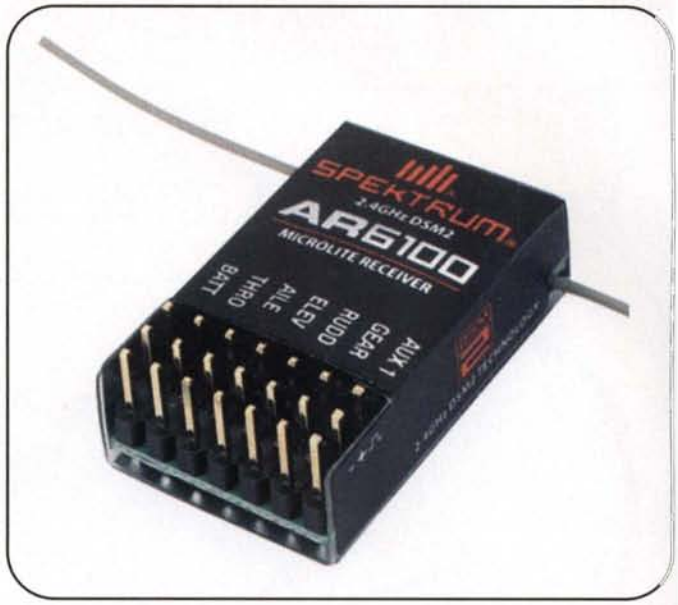
A Spektrum-brand transmitter module available for JR or Futaba transmitters.



Spektrum single receiver without dual diversity for close-range flying.

Module-equipped JR transmitters available for 2.4 GHz, 50 MHz, or 72 MHz.

purchase a complete, new dedicated 2.4-GHz SS transmitter.

There is some question as to whether 2.4-GHz SS has the range of the older VHF systems, but so far the performance looks good, with very few problems reported. The manufacturers are using exotic techniques such as dual-diversity reception. You be sure they would not have done that if they were not already on the edge of having range issues.

The advantage of this new equipment is the promise of no interference and no worry about channels, and the antennas are smaller and easier to deal with. The disadvantage is that they are more expen-

A new Futaba transmitter with 2.4 GHz built in.

sive than VHF equipment and there is less to choose from, but this surely is a temporary issue.

The manufacturers seem to be discontinuing VHF RC equipment, especially on 6 meters. However, there is one company, Sombra Labs (its products carried by West Mountain Radio), that just came out with a new state-of-the-art, fully synthesized 6-meter RC transmitter. Consider that you may not be able to get 6-meter equipment much longer. I would love to switch over to 2.4-GHz SS, but it would cost me a fortune to re-equip my over 30 airplanes, not to mention the time it would take to do that with reprogramming and retest flying them.

The new 50-MHz Sombra Synthesized DSP receiver.

Even though 2.4 GHz is a ham band, there is no license required. It pretty much looks like 6-meter and 72-MHz RC radios will be extinct very soon as technology changes within our hobbies.

I have enjoyed writing this column and I hope you have enjoyed reading it, but I have decided that this will be last one. I hope that I have pretty much covered everything I wanted to and have given my fellow hams a good insight into RC modeling, a great companion hobby to amateur radio. Happy flying!

73, Del, K1UHF

Links

http://www.futaba-rc.com
http://www.jrradios.com
http://www.sombralabs.com
http://www.spektrumrc.com
http:/www.westmountainradio.com

By Tomas Hood,* NW7US

PROPAGATION

The Science of Predicting VHF-and-Above Radio Conditions

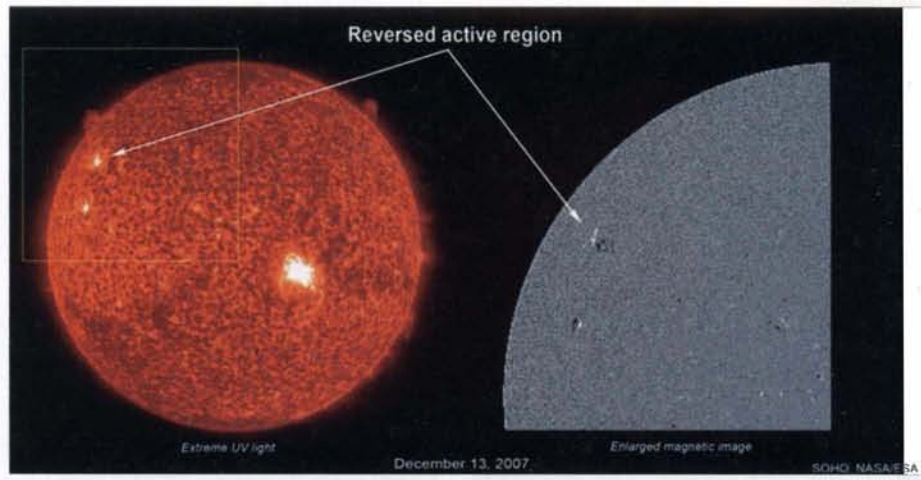
The New Solar Cycle Has Begun!

January 4, 2008 was a pretty exciting day for solar scientists, as well as amateur radio operators. When observers took a close look at the day's images of the sun, they noticed that a small sunspot had developed with a much-anticipated feature—a reversed magnetic polarity. Such a reversal marks the start of the new solar cycle, the 24th recorded cycle.

The excitement actually started in December, when a magnetically reversed, highly active region appeared in the sun's eastern limb. Because of its reversed polarity, scientists became hopeful that the region would develop into an actual sunspot. If it had, then scientists would have declared the official start of Cycle 24.

Sunspots have a complex magnetic structure. Typically, though, a sunspot will have at least one very clearly defined set of magnetic poles, north and south. At the start of a new solar cycle, the polarities of the new cycle's sunspots are reversed from the polarities observed in sunspots belonging to the previous cycle. When the first sunspot arrives with a reversed magnetic structure, scientists declare the start of the new cycle. This occurred on January 4, 2008.

What is in store for 2008? Solar cycles take anywhere from two to five years to reach the point of maximum solar activity. The current consensus among most solar scientists places Cycle 24's maximum sometime between 2011 and 2013. That means we have at least a year or two before we see major solar activity of the kind useful to VHF propagation. However, that does not mean that 2008 will be a disappointment for VHF DXers.



This UV-wavelength image of the sun (left) and a map showing positive (white) and negative (black) magnetic polarities (right) illustrate an active region that sparked a lot of excitement in December 2007. The new high-latitude active region was magnetically reversed, marking it as a harbinger of a new solar cycle. If the active region turned into an actual sunspot, scientists would have declared the start of solar Cycle 24 during December. However, a sunspot group never developed with a reversed polarity during December. (Source: SOHO/NASA)

Space Weather and VHF Propagation

Since the sun's magnetic field permeates the entire solar system and beyond (in a region called the *heliosphere*), it interacts with the Earth's magnetic field (a field known as the *magnetosphere*). The sun's huge magnetic field is called the *Interplanetary Magnetic Field* (IMF) and is a primary cause of space weather. Sprawling out away from the sun is a solar wind that rides the IMF.

As Earth orbits the sun, it dips in and out of the wavy current sheet of the IMF, known as the *Parker Spiral*. On one side the sun's magnetic field it points north, or toward the sun. On the other side it points south, or away from the sun. The IMF's orientation is indicated by the "B_z" index. When the B_z is negative, it indicates a southerly orientated IMF; when iy is positive, it indicates a northerly oriented IMF.

South-pointing solar magnetic fields tend to "magnetically reconnect" with Earth's own magnetic field. This allows the solar wind, and the solar plasma that is riding the solar wind out away from the sun, to flow in and collect in a reservoir known as the *boundary layer*. The energetic particles riding the solar wind can then penetrate the atmosphere and trigger geomagnetic storms, as well as aurora.

If the IMF is oriented northward, however, this magnetic reconnection does not take place. This instead creates a barrier against the solar wind and the plasma riding the IMF.

Solar plasma originates from a number of solar features, including coronal holes, coronal mass ejections (CMEs), and coronal jets. Coronal holes are regions in the sun's corona (an atmospheric layer of the sun that could be thought of as one of Earth's atmospheric layers, like the stratosphere) where the corona is darker than the surrounding area. These features were discovered when X-ray telescopes were first flown above the Earth's atmosphere to reveal the structure of the corona across the solar disc. Coronal holes are associated with "open" magnetic-field lines and are often found at the sun's poles. A coronal hole simply means an area where a breakdown in the magnetic fields in the solar corona has occurred. Often high-speed solar wind is known to originate in coronal holes. This escape of solar plasma and energy streams outward away from the sun into the solar wind. It

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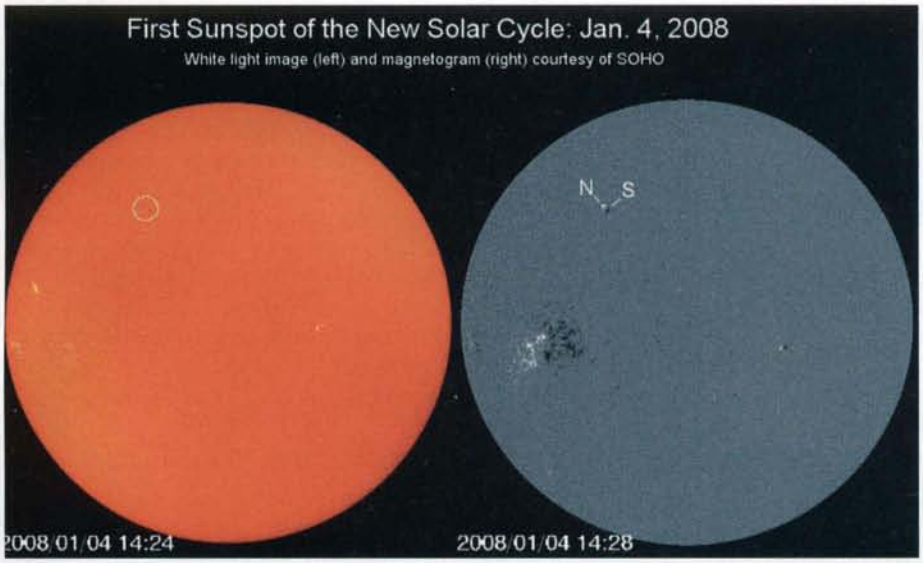

On January 4, 2008 a magnetically reversed sunspot emerged at solar latitude 30 north. This marked the start of solar Cycle 24. The sunspot, numbered 981, is the first to appear with a reversed magnetic polarity. The reversal is in relation to the polarity found in the sunspots occuring during Cycle 23. (Source: NASA/SOHO)

is the existence of coronal holes that will play a significant role in 2008's Spring Equinoctial season.

Winter 2008

Each year we have two seasons when significant space weather has a greater influence in causing geomagnetic disturbances: The first is known as the Spring Equinoctial season; the second is known as the Autumnal Equinoctial season. The Spring Equinoctial season peaks between March and April of each year; during this year's equinoctial season, there is moderate chance of geomagnetic activity combined with space weather to trigger small to medium aurora events.

Known as the Vernal Equinox, March 20, 2008 at 0548 UTC, the hours of daylight and darkness are about equal around the world. It is well-documented that this is one of the two optimal times of the year for aurora. Geomagnetic storms that ignite auroras occur more often during the months around the equinoxes during early autumn and spring. This seasonal effect has been observed for more than 100 years.

These two seasonal peaks in yearly auroral activity occur because the Earth's magnetic dipole axis is most closely aligned with the Parker Spiral in April and October. As a result, southward (and northward) excursions of B_z are greatest then. This is why aurora is most likely and strongest during the equinoctial months. When you see the solar wind speed increase to over 500 kilometers per second, and the B_z remains mostly negative (the IMF is oriented mostly southward), expect an increase in geomagnetic activity, as revealed by the planetary *K*-index (*Kp*).

What is Aurora?

Aurora is a direct result of solar plasma interacting with gasses in the upper atmosphere. It is common to see aurora during active to severe geomagnetic storms. The magnetosphere is filled with electrons and protons that normally are trapped by lines of magnetic force that prevent them from escaping to space or descending to the planet below. The influence of solar wind that has been enhanced by coronal holes can cause some of those trapped particles to break loose, causing them to rain down on the atmosphere. Gasses in the atmosphere start to glow under the impact of these particles. Different gasses give out various colors. Think of a neon sign and how the plasma inside the glass tube, when excited, glows with a bright color. These precipitating particles mostly follow the magnetic-field lines that run from Earth's magnetic poles and are concentrated in circular regions around the magnetic poles, and are called *auroral ovals*. These bands expand away from the poles during magnetic storms. The stronger the storm, the more these ovals will expand. Sometimes they grow so large that people at middle latitudes, such as in California, can see these "Northern Lights."

When you see the solar wind speed increase to over 500 kilometers per second, and the B_z remains mostly negative (when the Interplanetary Magnetic Flux is oriented mostly southward), expect an increase in geomagnetic activity, as revealed by the planetary *K*-index (*Kp*).

When the *Kp* rises above 4, look for aurora-mode propagation. The higher the *Kp*-index, and the longer the geomagnetic storminess lasts, the more likely we'll have strong aurora openings. You don't have to see them to hear their influence on propagation. Listen for stations from over the poles that sound raspy or fluttery. Look for VHF DX. Sometimes it will enhance a path at certain frequencies, while other times it will degrade the signals. Sometimes signals will fade quickly and then come back with great strength. The reason for this is the radio signal is being refracted off the more highly ionized areas that are lit up. These ionized areas ebb and flow, so there is the ability to refract changes, sometimes quickly. I've observed the effect of aurora and associated geomagnetic storminess even on lower HF frequencies.

Radio Aurora

If there are enough solar particles flowing down the Earth's magnetic-field lines and colliding with atmospheric atoms and molecules, ionization occurs. This ionization may be sufficient to reflect VHF and lower UHF radio waves, generally between 25 and 500 MHz. This usually occurs in conjunction with visual aurora, but the mechanism is a bit different and it is possible to have one (visual or radio) without the other.

Using radio aurora, the chances of contacting stations over greater distances than would ordinarily be possible on the VHF frequencies is increased. Like its visual counterpart, radio aurora is very unpredictable. The thrill of the chase draws many VHF weak-signal DXers to working auroral DX.

VHF auroral echoes, or reflections, are most effective when the angle of incidence of the signal from the transmitter, with the geomagnetic field line, equals the angle of reflection from the field line to the receiver. Radio aurora is observed almost exclusively in a sector centered on magnetic north. The strength of signals reflected from the aurora is dependent on the wavelength when equivalent power levels are employed. Six-meter reflections can be expected to be much stronger than 2-meter reflections for the same transmitter output power. The polarization of the reflected signals is nearly the same as that of the transmitted signal.

The *K*-index is a good indicator of the expansion of the auroral oval, and the possible intensity of the aurora. When the *K*-index is higher than 5, most hams in the northern states and in Canada can expect favorable aurora conditions. If the *K*-index reaches 8 or 9, it is highly possible for radio aurora to be worked by stations as far south as California and Florida. Your magnetic latitude can be found using the map at <http://www.sec.noaa.gov/Aurora/globeNW.html>.

The Solar Cycle Pulse

The observed sunspot numbers from October through December 2007 are 0.9, 1.7, and 10.1. (A correction to the numbers reported in the last issue: July through September observed sunspot numbers are 10.0, 6.2, and 2.4). The smoothed sunspot counts for April through June 2007 are 9.9, 8.7, and 7.7.

The monthly 10.7-cm (preliminary) numbers from October through December 2007 are 65.5, 69.7, and 78.6. The smoothed 10.7-cm radio flux numbers for April through June 2007 are 75.2, 74.2, and 73.2.

The smoothed planetary *A*-index (*Ap*) numbers from April through June 2007 are 8.5, 8.4, and 7.8. The monthly readings from through December 2007 are 9, 5, and 4.

The smoothed monthly sunspot numbers forecast for January through March 2008 are 4, 3, and 3, while the smoothed monthly 10.7-cm is predicted to be 62, 62, and 61 for the same period.

(Note that these are preliminary figures. Solar scientists make minor adjustments after publishing, by careful review.)

Feedback, Comments, Observations Solicited!

I am looking forward to hearing from you about your observations of VHF and UHF propagation. Please send your reports to me via e-mail, or drop me a letter about your VHF/UHF experiences (sporadic-E, meteor scatter?). I'll create summaries and share them with the readership. You are also welcome to share your reports at my public forums at <http://hfradio.org/forums/>. Up-to-date propagation information is found at my propagation center, <http://prop.hfradio.org/> and via cell phone at <http://wap.hfradio.org/>.

Until the next issue, happy weak-signal DXing. 73 de Tomas, NW7US

Cycle 24 Begins!

Has sunspot Cycle 24 finally begun? Here KH6/K6MIO follows up on his article in the Fall 2007 issue of *CQ VHF* with a report on what seems to be the positive indicator that the new cycle has begun.

By Jim Kennedy,* KH6/K6MIO

Six-meter devotees have anxiously been awaiting the peak years of solar Cycle 24 and the return of good ionospheric DX conditions. In December 2007 and January 2008 we saw the first solid indications that Cycle 24 is beginning to rev up.

At the end of one cycle and the beginning of the next cycle, there is a period of time when the two cycles overlap. Magnetically active regions and associated sunspots from both cycles are seen on the sun at the same time.

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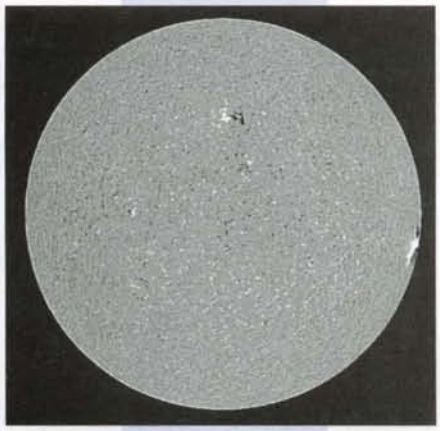
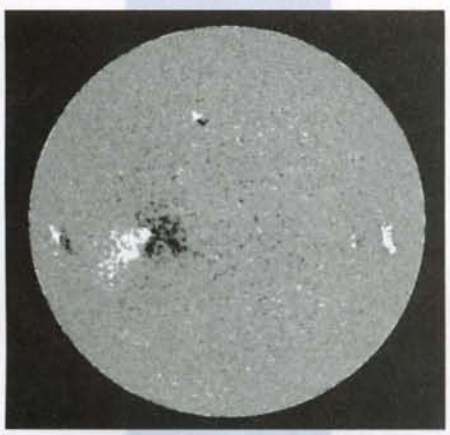


An NSO solar magnetogram from December 18, 2007 shows the magnetic pair 30N-145. Note its position in the dateline in figure 1. (Credit: NSO/AURA/NSF)



An NSO solar magnetogram from January 5, 2008 shows the magnetic pair 30N-250. Note its position in the dateline in figure 1, along with much larger 10S-240 and smaller 10N-330 groups from Cycle 23. (Credit: NSO/AURA/NSF)

Sunspots always appear as pairs in active regions. Powerful dipolar magnetic fields connect the leading and following spot in each pair, giving the pair a characteristic magnetic polarity. In one of the sun's (north/south) hemispheres, the field will point outward from the leading spot and inward to the following spot, and in the other hemisphere it will be *exactly the opposite*—inward to the leading spot and outward from the following spot.

These characteristics make it possible to readily tell the difference between the old-cycle and new-cycle regions:

1. Old-cycle spots are *near the equator*, with their spot-pair polarities opposite in the Northern and Southern Hemispheres.

2. New-cycle spots are *near 30°* north and south latitudes, with *north and south polarities that are reversed* from that of old-cycle pairs.

The beginning of each new cycle is indicated by the sustained appearance of these *30° latitude, reversed-polarity* magnetic active regions, often with spot pairs or groups.

There was a brief appearance of a small reversed-polarity spot pair near 30° south in July 2006, but it vanished almost immediately. It was a fluke; nothing further was seen for 17 months.

That changed on December 11, 2007, when an already-formed reversed-polarity active region pair rotated over the limb into view. While no actual sunspots formed, the magnetic structure was clear. The system grew in size for a few days and then began to diminish and rotated out of view on the 23rd. Then, on January 2, 2008, another reversed-polarity magnetic region (981) emerged and produced a small sunspot group. This was a second, distinct region and *not* a recurrence of the December group (see figure 1).

Since Northern Hemisphere activity has preceded that of the Southern Hemisphere for the last few cycles, and now two reversed-polarity northern groups have been seen, this is a good indication that Cycle 24 is finally arriving.

At this writing (early January), the R_i sunspot index has been very low (<12) since June 2007. It appears that solar minimum is very near, but may not have occurred yet. This would seem to eliminate all but three of the professional Cycle 24 predictions discussed in my previous article[1], as the others called for much earlier minimum dates.

Two of the remaining predictions are those from the strongly-split NOAA panel. While both factions on the panel predicted that minimum would occur in March 2008 plus or minus six months, one group predicted a very weak maximum (R_i max approximately 90), and the other predicted one stronger than Cycle 23 (R_i max approximately 140). The panel will review its findings in March 2008.

The third remaining prediction is that made by Mausumi Dikpati and her collaborators at the High Altitude Observatory, which calls for (R_i max approximately 169), and a minimum in late 2007 or early 2008. Only time will tell.

(For more information on the start of Cycle 24, see NW7US's "VHF propagation" column in this issue of CQ VHF.*)*

Note

1. Kennedy, Jim, KH6/K6MIO, "Solar Cycles and Cycle 24 Predictions," Fall 2007 *CQ VHF*, pp. 10–19.

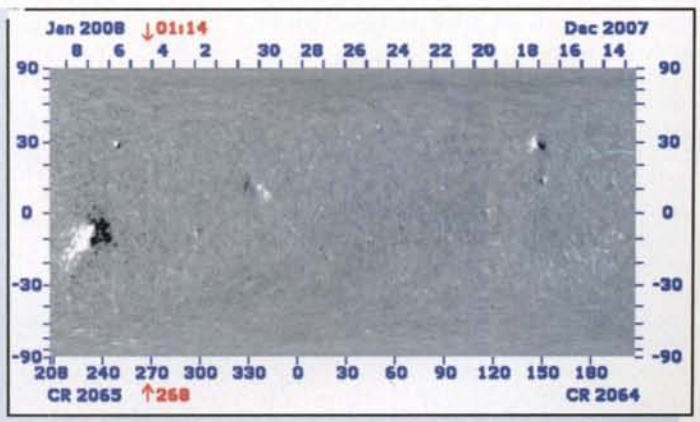


Figure 1. This Global Oscillation Network Group (GONG) magnetogram is a latitude-longitude map of the surface fields of the whole Sun from December 14, 2007 to January 8, 2008. The magnetic pairs at 30N-145 and 30N-250 are the December and January Cycle 24 regions, respectively. The large group at 10S-240 and the small group at 10N-330 are Cycle 23 regions. Note that the white/black polarity sense of the 30N Cycle 24 regions is the opposite of the 10N Cycle 23 region. (Credit: GONG/NSO/AURA/NSF)

QUARTERLY CALENDAR OF EVENTS

Current Contests

The **European Worldwide EME Contest 2008:** Sponsored by DUBUS and REF, the EU WW EME contest is intended to encourage worldwide activity on moonbounce. Information on this contest was not available at press time. Please check with N6CL's "VHF Plus" column in *CQ* magazine for a future announcement.

Spring Sprints: These short-duration (usually four hours) VHF+ contests are held on various dates (for each band) during the months of April and May. Please check with the "VHF Plus" column in *CQ* magazine for a future announcement.

The **2 GHz and Up World Wide Club Contest:** Sponsored by the San Bernardino Microwave Society, this contest runs in early May. Rules are available at the following URL: <http://www.ham-radio.com/sbms>.

Conference and Convention

Southeast VHF Society: The 12th annual conference will be hosted in Atlanta, Georgia, April 25 and 26, 2008 at the Holiday Inn/UCF, 12125 High Tech Ave., Orlando, FL (phone 407-275-9000). For information on registering for the conference, please check the society's website at <http://www.svhfs.org/>.

Dayton Hamention®: The Dayton Hamvention® will be held as usual at the Hara Arena in Dayton, Ohio, May 16–18, 2008. For more information, please see the website: <http://www.hamvention.org>.

Calls for Papers

Calls for papers are issued in advance of forthcoming conferences either for presenters to be speakers, or for papers to be published in the conferences' *Proceedings,* or both. For more information, questions about format, media, hardcopy, e-mail, etc., please contact the person listed with the announcement. The following organization or conference organizer has announced a call for papers for its forthcoming conference:

The **Southeast VHF Society** (see conference dates announcement above): The deadline for the submission of papers and presentations is February 29, 2008. All submissions should be in Microsoft Word (.doc) or alternatively Adobe Acrobat (.pdf) files. Pages should be 8 1/2 by 11 inches with a 1-inch margin on the bottom and 3/4-inch margin on the other three sides. All text, drawings, photos, etc., must be black and white only (no color). Please indicate when you submit your paper or presentation if you plan to attend the conference and present there or if you are submitting just for publication. Papers and presentations will be published in bound *Proceedings* by the ARRL. Send all questions, comments, and submissions to the technical program chair, Steve Kostro, N2CEI, at <svhfs2008@downeastmicrowave.com>. For further information about the conference go to <http://www.svhfs.org>.

The **Central States VHF Society Conference**: Technical papers are solicited for the 42nd annual Central States VHF Society Conference to be held in Wichita, Kansas on July 24–27, 2008. Papers, presentations, and posters on all aspects of weak-signal VHF and above amateur radio are requested. You do not need to attend the conference, nor present your paper, to have it published in the *Proceedings*. Posters will be displayed during the two days of the conference.

Non-weak signal topics, such as FM, repeaters, packet radio, etc., generally are not considered acceptable. However, there are always exceptions. Please contact the folks below if you have any questions about the suitability of a topic. Strong editorial preference will be given to those papers that are written and formatted specifically for publication, rather than as visual presentation aids.

Deadline for submissions: For the *Proceedings* June 2; for presentations delivered at the conference June 30; and for notifying them that you will have a poster to be displayed at the conference also June 30. Please bring your poster with you on July 25,. Contact information: Mel Graves, WRØI, via e-mail: <wr0i@sgdrugfree.com>, or snail mail at: Melvin Graves, WRØI, P.O. Box 273, Wichita, KS 67201-0273.

Submissions can be made via the following: Electronic formats (preferred); via e-mail; uploaded to a website for subsequent downloading; on media (3.5-inch floppy, CD, USB stick/thumb drive).

Quarterly Calendar

The following is a list of important dates for EME enthusiasts:

Feb. 3	Very poor EME conditions
Feb. 7	New Moon
Feb. 10	Good EME conditions
Feb. 14	First Quarter Moon and Moon Perigee
Feb. 17	Moderate EME conditons
Feb. 21	Full Moon and Total Lunar Eclipse visible throughout most of the Americas, Africa, and Europe
Feb. 24	Moderate EME conditions
Feb. 28	Moon Apogee
Feb. 29	Last Quarter Moon
March 2	Very poor EME conditions
Mar. 7	New Moon
Mar. 9	Good EME conditions.
Mar. 10	Moon Perigee
Mar. 14	First Quarter Moon
Mar. 16	Moderate EME conditions
Mar. 20	Spring Equinox
Mar. 21	Full Moon
Mar. 23	Moderate EME conditions
Mar. 26	Moon Apogee
Mar. 29	Last Quarter Moon
Mar. 30	Very poor EME conditions.
Apr. 6	New Moon; Good EME conditions
Apr. 7	Moon Perigee
Apr. 12	First Quarter Moon
Apr. 13	Good EME conditions
Apr. 20	Full Moon; Poor EME conditions
Apr. 22	*Lyrids* Meteor Shower Peak
Apr. 23	Moon Apogee
Apr. 27	Very poor EME conditions
Apr. 28	Last Quarter Moon
May 4	Good EME conditions.
May 5	*Eta Aquarids* Meteor Shower Peak and New Moon
May 6	Moon Perigee
May 11	Very good EME conditions
May 12	First Quarter Moon
May 18	Poor EME conditions
May 20	Full Moon and Moon Apogee
May 25	Poor EME conditions
May 28	Last Quarter Moon
June 1	Good EME conditions
June 3	Moon Perigee and New Moon
June 8	Excellent EME conditions
June 10	First Quarter Moon
June 15	Poor EME conditions
June 16	Moon Apogee
June 18	Full Moon
June 21	Summer Solstice
June 22	Poor EME conditions
June 26	Last Quarter Moon
June 29	Moderate EME conditions

—EME conditions courtesy W5LUU.

Meteor Showers

The *α-Centaurids* meteor shower is expected to peak on February 8 at 1700 UTC. The *γ-Normids* shower is expected to peak on March 13. Other February and March minor showers include the following and their possible radio peaks: *Capricornids/Sagittarids,* February 2, 0300 UTC; and *χ-Capricornids,* February 14, 0400 UTC.

The *Lyrids* meteor shower is active during April 16–25. It is predicted to peak around 0500 UTC on 22 April. This is a north-south shower, producing at its peak around 10–15 meteors per hour, with the possibility of upwards of 90 per hour.

A minor shower and its predicted peak is *pi-Puppids* (peak on April 23, at 1000 UTC). Other April, May, and June minor showers include the following and their possible radio peaks: April *Piscids,* April 20, 0300 UTC; *δ-Piscids*, April 24, 0300 UTC; *η-Aquarids*, May 5, 1800 UTC; *ε-Arietids*, May 9, 2000 UTC; May *Arietids,* May 16, 0300 UTC; and *o-Cetids,* May 20, 0100 UTC. June *Arietids,* June 7, 0500 UTC; *zeta-Perseids,* June 9, 0400 UTC; and *β-Taurids*, June 28, 0400 UTC.

For more information on the above meteor shower predictions please visit the International Meteor Organization's website: <http://www.imo.net>.

By Bill Brown,* WB8ELK

UP IN THE AIR

New Heights for Amateur Radio

Transatlantic Balloon Race

Part of the fun and challenge of Amateur Radio High Altitude Ballooning (ARHAB) is to push the envelope towards new achievements. Ralph Wallio, WØRPK, maintains an ARHAB Flight Records page on his website (www.arhab.org) that documents some of these achievements. Each year a contest is held with categories such as Highest Altitude, Longest Flight Time, Greatest Flight Distance, Greatest Telemetry Reception Range (VHF/ UHF), Greatest Telemetry Reception Range (HF), and Greatest Two-Way QSO via balloon transponder or repeater.

Several balloon groups have been pushing towards the ultimate goal of having a balloon repeater/transponder that flies for several days at high altitude. Imagine having the equivalent of an AMSAT satellite that floats slowly across the U.S. (or around the world) for hours or days. The great advantage of a BalloonSat is that due to its slow speed relative to an AMSAT bird and its closer proximity to Earth, anyone with a modest amateur radio station can easily work through the balloon relay without worrying about slinging antennas rapidly across the sky, and much lower power is necessary to make a contact. Some of the two-way QSOs that were made via a VHF/UHF balloon repeater have been over 700 miles (a 777-mile DX QSO is the record so far, set by N8DEZ/6 and N5QO via the ANSR balloon relay from Phoenix, Arizona).

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The Contenders

One of the ultimate goals, and also the toughest to achieve, has been to lob a balloon payload clear across the Atlantic Ocean. The unmanned balloon equivalent of Charles Lindbergh's transatlantic solo flight, a handful of balloon groups have taken up the challenge and the race is on!

It turns out that the best time of year to achieve a transatlantic flight is during the winter months. The jet stream can exceed

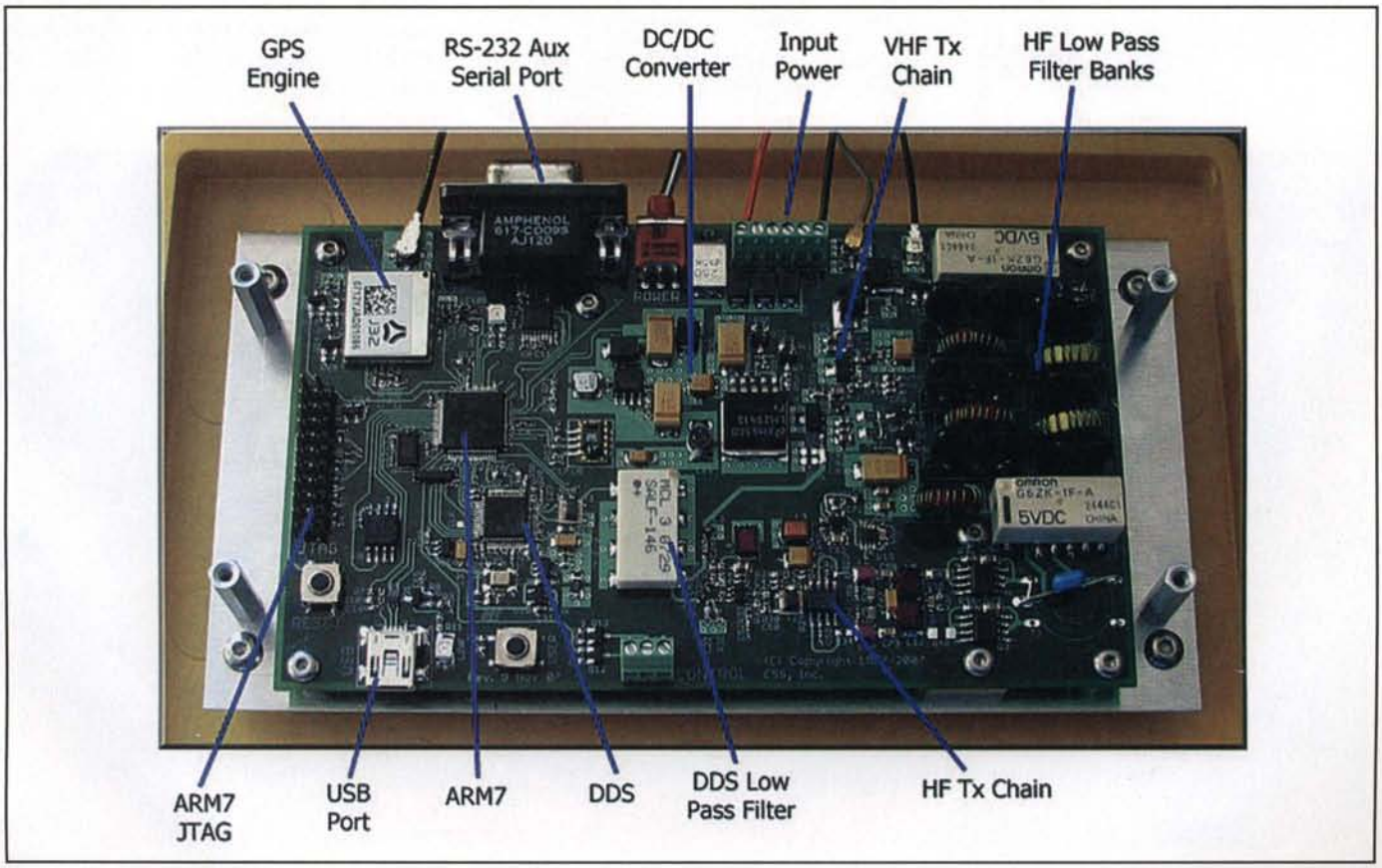


Photo 1. The HF PSK-31 and VHF APRS ANSR long-duration payload PC board. (Photo by Michael Gray, KD7LMO)

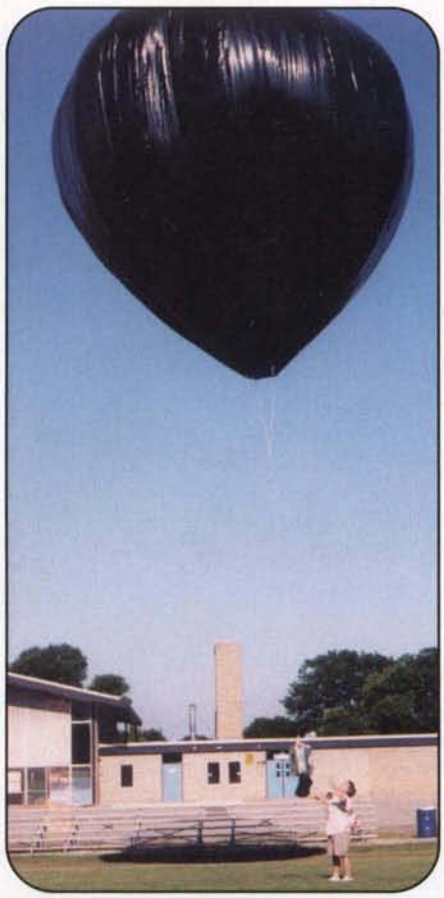


Photo 2. Robert Rochte, KC8UCH, launches his solar balloon from Grosse Pointe Academy.

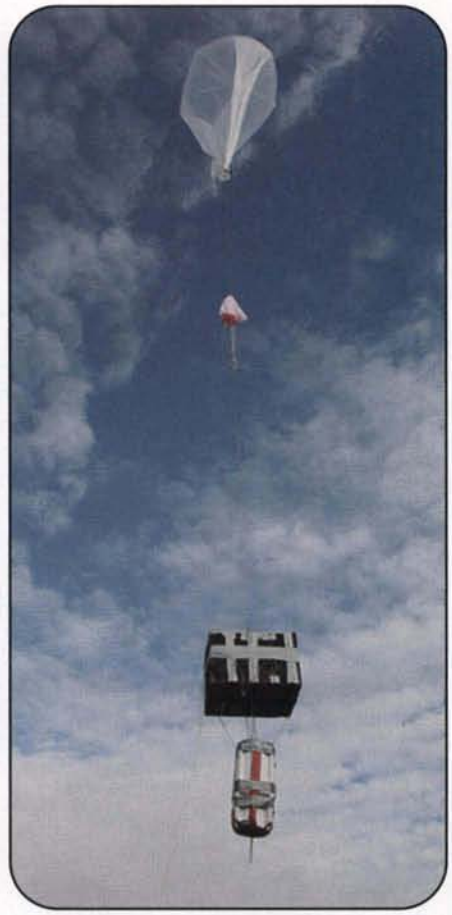


Photo 3. Launch of the UTARC Spirit of Knoxville UX-19 balloon.

170 knots at this time of year, and the trend is for a flight that goes east at a high speed. Some days the winds are so strong that a balloon could make the transit in less than 48 hours.

So far four groups have thrown their hats in the ring, and there could be a few more as the competition heats up. In alphabetical order, here are the current contenders:

ANSR

The Arizona Near Space Research (ANSR) group (www.ansr.org) plans to fly a custom-built payload that includes APRS as well as PSK-31 telemetry (see photo 1). Using a circuit designed and built by Michael Gray, KD7LMO, this multi-band HF PSK-31 telemetry transmitter can be heard for thousands of miles, allowing anyone with a modest HF PSK-31 station to follow the flight's progress. (Michael's innovative circuit designs can be viewed at: <www.kd7lmo.net>.)

In addition to its extensive student experiment program using conventional latex balloons, ANSR has achieved some remarkable long-duration flights using a special plastic balloon designed and supplied by Mark Caviezel of Global Western. The group has made several multi-day flights so far, and the longest

Photo 4. WB8ELK's Hi-Ball 8 long-duration balloon launch (left to right): Barry, N4MSJ; Thad, WB4VHF; Jason, KG4WSV; Gary, N4TXI; and Jim WA8VWY.

mission has been 775 miles downrange. If ANSR makes it across the Atlantic, it will indeed be quite an achievement, since the group has the disadvantage of having to trek across most of the continental U.S. before reaching the Atlantic seaboard.

Grosse Pointe Academy

Robert Rochte, KC8UCH, has been researching and building unique experimental balloon designs and has achieved amazing results using super-pressure balloons made out of mylar, as well as solar balloons that require no helium (see photo 2). Many of his solar balloons have carried APRS transmitters up to over 65,000 feet, and they have floated there all day long until the sun went down. He's had many flights of several hundred miles, and his farthest was a landing in New Brunswick, Canada, 933 miles. His longest duration flight so far was a super-pressure design that stayed up 32 hours carrying a 5-ounce APRS payload. Robert is Director of Technology at Grosse Pointe Academy in the Detroit, Michigan area and involves his students in the entire process (see <http://mail.gpacademy.org/~rochter/default.htm>). The students build the balloon in the classroom as well participate in the launch, data collection, and tracking of the mission. This is a wonderful hands-on way of teaching science and engineering in a way that few students get to experience. Robert has a ballooning blog at the following address: (http://arhab.blogspot.com/).

UTARC

Members of the University of Tennessee Amateur Radio Club (UTARC) in Knoxville, Tennessee have been actively pursuing long-duration flight with a number of innovative flights (see photo 3). Their transatlantic effort has been dubbed "The Spirit of Knoxville" (www.spiritofknoxville.com), and they maintain a unique website that links into the APRS server system as well as their own internet-linked RTTY (Radio Teletype) system to provide real-time charts of the balloon's telemetry. Their web-linked RTTY system is particularly unique in that they have developed a web-server-linked interface to the popular MMTTY program that they call DTRC (Distributed Tracking and Relay Client). It's a free RTTY decoder program and allows anyone who receives the HF RTTY signal from the balloon to automatically send what they receive directly to the UTARC team. In addition, any ham can view online what other hams have decoded on RTTY anywhere in the world. So far they have the record for farthest HF telemetry reception by DJ1YFK at over 4572 miles. Their most recent flight splashed down in the Atlantic way past the South Carolina coast after flying 589 miles. They plan to transmit on 144.39 APRS while over the US mainland, and then start transmitting standard 45-baud RTTY and CW on the 30-meter band while over the Atlantic and flying a Global Western balloon.

WB8ELK

I have longed dreamed of flying a balloon across the "pond." Over the past few years I have done a number of test flights using both plastic balloons and traditional latex balloons (see photo 4). My transatlantic effort will consist of a 30-meter and 20-meter standard RTTY and CW transmitter sending down location and altitude as well as APRS on 144.39 MHz until it's past VHF range to the shoreline. Based in the Huntsville, Alabama area, it doesn't take more than a few hours to make it out over the Atlantic if the upper altitude winds are high.

Over the years, I've dropped a dozen payloads into Davy Jones's locker. My most recent series of transatlantic test flights have dropped four payloads into the Bermuda Triangle. My farthest flight so far was 1400 miles downrange, and the balloon splashed down off the coast of Nova Scotia after flying for over 22 hours. I will also be using a Global Western balloon supplied by Mark Caviezel. Updates and flight results can be viewed on my website: (www.wb8elk.com).

Due to the wonders of HF propagation, anyone can track these flight attempts using just a free sound-card decoding program. As always, you can find out when these efforts will fly by checking out the national Amateur Radio High Altitude Balloon website, <www.arhab.org>, where most balloon flights are posted in advance.

73, Bill, WB8ELK

By Dr. H. Paul Shuch,* N6TX

DR. SETI'S STARSHIP

Searching For The Ultimate DX

Millimeter Magic

Where, exactly, within the vast electromagnetic spectrum are we most likely to detect radio evidence of our cosmic companions? The question is important to practitioners of SETI science, professional and amateur alike, because our terrestrial technology is limited. Wouldn't it be wonderful if we could view the whole spectrum, DC to daylight, in real time? We're talking about the ultimate panadaptor. However, that's a little like trying to monitor every frequency on every ham band simultaneously in order not to miss the next opening to that elusive DX station.

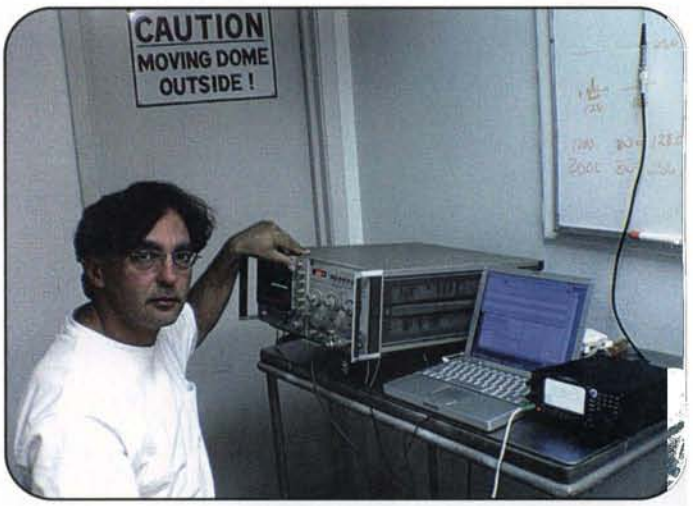
The DX that SETIzens seek, however, is even more elusive than the rarest uninhabited island which might some day be activated. At least, when a trek is mounted to a remote corner of planet Earth, we know the DXpedition's destination, what bands the team members plan to operate, what callsign they will use, their preferred modulation modes, and how long they plan to be there. With interstellar DX, we don't even know for sure that they *exist,* much less the particulars of their QTH, operating schedule, or band plan. Lacking any *a priori* knowledge, all we can do is guess, and the better we guess, the greater our chance of success.

The first scientific paper proposing modern SETI, co-authored by Prof. Phil Morrison, W8FIS, back in 1959, appeared in the prestigious British science journal *Nature.* In it, Morrison and his colleague Giuseppi Cocconi grappled with the concept of *magic frequencies,* those calling channels that Nature has carved into the cosmic bandplan, which would be obvious to any thinking creature on a planet orbiting any star. The assumption of mediocrity suggests that if we on Earth can figure out the bandplan, then our potential DX (being, we presume, more intelligent than we) will have figured it out as well. Morrison's and Cocconi's suggestion, the neutral hydrogen emission line at 1420.405751692 MHz, has been the starting point for nearly all the SETI searches that have followed. Hydrogen is, after all, the most abundant element in interstellar space, and it emits a clearly detectable, narrow-band calibration signal for all who care to tune its way. Surely if we can see that, so can *they.*

After nearly half a century of trying, though, we have yet to detect the interstellar CQ, on the hydrogen line or the myriad other magic frequencies we have monitored with Earth's best radio telescopes. Could it be we're listening on the wrong channel?

Peter Vekinis, LX1QF, thinks so. He speculates that advanced extraterrestrial civilizations will announce their presence in the millimeter-wave spectrum. Peter recently concluded two days of SETI observations from the 12-meter diameter radio telescope on Kitt Peak, Arizona. He selected ten frequencies between 115 and 177 GHz, associated with natural emission lines from molecules of biological significance on Earth. If organic processes are similar throughout the cosmos, Peter reasoned, then one or more of these frequencies might be obvious to the beings we seek to detect.

Peter's logic seems reasonable. If we are a typical example, then as civilizations advance technologically, they naturally gravitate toward ever higher frequencies. Yet the truth is that we're not all that advanced. It's easy for Earth's radio amateurs to monitor the 21-cm hydrogen line (after all, it's just up the road from the popular 23-cm ham band and our equipment tweaks up there quite readily). However, how many of us routinely tune the rarefied bands around 170,000 MHz? I venture to guess one could count them on the thumbs of one hand.



SETI League member Peter Vekinis, LX1QF, on site at the 12-meter diameter millimeter-wave radio telescope on Kitt Peak, near Tucson, Arizona, in November 2006 scanning for intelligent extraterrestrial signals. Peter conducted a two-day observing run in the 170-GHz spectral region. His raw data, recorded as audio .WAV files, was made available for SETI League members to download and analyze. So far, no signal of obvious intelligent extraterrestrial origin has been found buried in the mm-wave noise.

In just two nights of listening, Peter Vekinis recorded hundreds of gigabytes of noise. Somewhere, buried in that noise, he hoped to find ET, but sifting through so large a data set is a daunting task. To spread the workload among The SETI League's 1500 members, he put his data files on the web and encouraged his fellow members to apply their very best DSP techniques to the analysis. Several have risen to the challenge, although none has yet hit paydirt.

Recognizing that downloading of GB-size files requires a broader bandwidth than the connection most of us enjoy, The SETI League decided to make the entire data set available on DVD. These disks are provided free of charge to SETI League members in good standing. If you want to lend a hand, first join our grass-roots, membership-supported, nonprofit ham club via <http://www.setileague.org>. Include with your membership application a note saying, "send LX1QF DVD," and we'll respond as quickly as an all-volunteer organization is able.

Vekinis is fortunate to have occasional access to one of the world's great millimeter-wave radio telescopes. Most of us are not so blessed. Therefore, until KenYaeCom starts advertising mm-wave rigs in the pages of *CQ VHF,* chances are we'll all be stuck in the low microwave realm, hoping some benevolent extraterrestrial DX club will choose to put up a beacon on the Novice bands.

Still, when that first 170-GHz rig hits the market, I plan to buy one and join Peter Vekinis in listening on one of his magic frequencies. I hope you will, too. 73, Paul, N6TX

*Executive Director Emeritus, The SETI League, Inc.,
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Ultra compact HF, VHF, UHF

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FT-2000
- 200 W Version with External Power Supply
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Compact size : 9" X 3.3" x 8.5" and Light weight : 7.9

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