

2009 Teachers Institute Introduces Advanced Satellite Workshop



An earth-bound education about satellite communication.

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In the summer of 2009 the ARRL Education & Technology Program (ETP) offered eight Teachers Institutes seminars for 94 teachers from 30 states. As in the past, Teachers Institutes were held at various venues across the country with sessions in Arizona, California, Florida, Michigan, New Mexico, Ohio and wrapped up with a session at the ARRL headquarters in Connecticut. This increased tempo of offerings was made possible by the addition of instructors Miguel Enriquez, KD7RPP, and Nathan McCray, K9CPO, who joined the author to expand the Teachers Institute instructor team.

The basic Teachers Institute workshop is an intensive 4 day session of professional development training for classroom teachers. It provides them with a foundation in basic electronics, the science of radio, methods for bringing space technology into the classroom, microcontroller programming and basic robotics. This year the space in the classroom unit was expanded for a few previous Teachers Institute graduates who attended an advanced workshop, known as the "TI-2."

TI-2: Bringing Satellites to Students

The inaugural TI-2 focused on assembling and integrating the equipment and software required to set up a satellite ground station and on how to operate the ground station to communicate with other hams via ham radio satellites. Then participants learned how to

Above: The TI-2 participants with their antennas, rotators and Yaesu ground stations — all smiles after successfully completing their first AO-51 contacts. From the left are Kenneth De Lucca, WA3KD; Bob Houghton, AD6QF; Joel Wagener, N2IAG; Matt Severin, N8MS; Michael Riley, N9LTT; James Fitzgerald, KC8WWJ; Nathan McCray, K9CPO; Miguel Enriquez, KD7RPP and Rod Marty, NA9N.



Miguel Enriquez, KD7RPP, and Jim Fitzgerald, KC8WWJ, make last minute adjustments to prepare their station for the next pass of the satellite.

intercept, copy, decode, interpret and use satellite telemetry in the classroom.

An additional goal of this Institute was to test and verify a model curriculum for possible use in future Teachers Institutes. This new curriculum prepares teachers to participate more fully in the Amateur Radio on the International Space Station (ARISS) program, giving them the training to play a more active and pivotal role in the preparation for the ARISS contact (how to assemble and use a ground station) and in the execution of the ARISS contact. The curriculum also offers tools and resources that will allow the teachers to develop a portfolio of space-related activities.

At the TI-2 workshop, each of the participants successfully assembled *their* station. Each participant received the station to take home and set up in their home school — a special thanks to Yaesu and Ham Radio Outlet for their generous support, making the purchase of this equipment affordable. The stations included a Yaesu G-5500 rotator, rotator controller interface, a Yaesu VR-5000 receiver, Arrow antenna and ancillary cables and coax to complete the station.

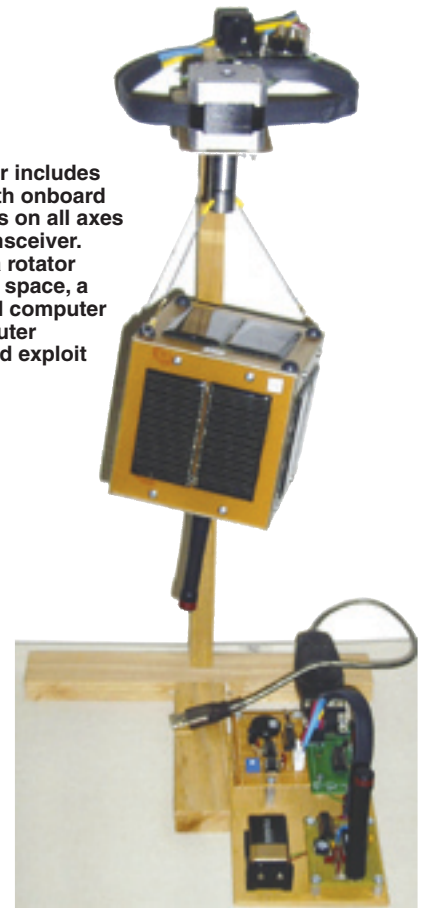
Once the stations were assembled, each participant successfully completed on-the-air contacts with fellow ham radio operators on AO-51 and AO-27. Finally, each participant successfully copied the telemetry sent from numerous CubeSats. They received instruction in receiving satellite telemetry sent via Morse code and then how to put those new learned skills into

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This picture says it all — Matt Severin, N8MS, making a contact on the satellite ground station he assembled — now on to the classroom.

The CubeSat Simulator includes a full size CubeSat with onboard computer, solar panels on all axes and UHF data link transceiver. The system includes a rotator to simulate rotation in space, a telemetry receiver and computer interface, and a computer program to display and exploit telemetry data.



practice to decode the satellite telemetry and understand the satellite system's operational measurements. And the learning is just beginning. Once the satellite system measurements are in the hands of the students, students can graph and interpret what the telemetry is telling them about the health and operating condition of the particular satellite.

CubeSat Simulator

Additionally, a CubeSat Simulator that is being developed through the ETP was unveiled at the TI-2. The CubeSat Simulator is an affordable resource that will soon be made available to schools through the ETP grant program. It is designed to allow teachers to simulate satellite operations in the classroom by allowing the students to "experience" satellite telemetry transmission in either binary format or Morse code to better prepare them for "live" telemetry transmissions from spacecraft.

The Teachers Institute program is one component of the grant offerings within the Education & Technology Program. The ETP makes a variety of resources available to schools and school teachers to help integrate wireless technology into school curricula using ham radio as an educational tool. The ETP is possible only because of the generous donations of individuals and clubs who share in the passion of ham radio.

Was It Worthwhile?

The success of the Teachers Institutes is best told by the participants themselves. Teachers shared these comments:

"I learned a lot more about operating satellites than I expected. It was both interesting

and exciting. I am looking forward to my students having this experience."

"If there were one thing I would want my students to take away from my classroom, it would be this kind of resourceful thinking that facilitates problem-solving. I believe Ham Radio is one of the few places where a student can build experience with practical, hands-on problem-solving. TI-2 provided a vehicle for developing that skill as an important added benefit to the excitement of learning about satellites. Thanks to you and to those who made this program possible."

"Thanks for putting TI-2 together for us; I am really excited to get my station up and running at school to share my new knowledge with my kids. Having you to take us through setting up our station step by step saved countless hours of trial and error, and really keeps my motivation and enthusiasm high. I see so much potential for my school as I plan to incorporate this unique tool into my school."

"I also think incorporating the satellite simulator will be a huge plus. I can imagine all kinds of ways to use it if I were still teaching Earth Science. I will be interested to get my hands on one once you are ready for production... I want to see if I can figure out the best way to use it at the Elementary level."

"Like the original Teacher's Institute, I found TI-2 to be a very satisfying experience on both a personal and professional level. I liked that there was an expectation that the participants already had a good foundation in wireless technology. I have been to many workshops where the pace was so slow that my attention drifted. There was absolutely no chance of that happening at TI-2! This was like graduate

school for Amateur Radio! The workshop is a great follow-on for TI for teachers who want to further their understanding of orbital mechanics and space communications."

"In a short period of time, I am sure that many of us will probably be looking for other additional things we can do to build on what we learned. For example, I will very soon be trying some satellite packet, and looking into SSTV."

"I am convinced that the NASA Aerospace Education Services Project would benefit from further professional development in the areas of Amateur Radio and electronics. As I have started to read the book that was provided I am amazed at the part amateur radio has played in the spacecraft communications accomplishments. I am also encouraged to spend more time developing my own AR skills and equipment."

"Thanks again for an awesome session. It was everything that I expected."

Now the real work begins — applying what was learned during the Teachers Institutes in the classroom.

Find more information about ARRL's Education & Technology Program at www.arrl.org/ETP.

All photos by Mark Spencer, WA8SME.

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