Amateur Radio on the International Space Station
Annual Report 2007

Introduction

Amateur Radio on the International Space Station (ARISS) is an educational outreach program sponsored by NASA, in which students engaged in a science and technology curriculum are given the opportunity to speak with the International Space Station (ISS) on-orbit crew. Using amateur radio, the students ask questions about life in space or other space-related topics. Students fully engage in the ARISS contact by helping set up an amateur radio ground station at the school and then using that station to talk directly with the onboard crew member for approximately ten minutes, the time of an ISS overhead pass. Preparation for the experience motivates the children to learn about radio waves, space technology, science, geography and the space environment. In many cases, the students help write press releases and give presentations on the contact to their fellow students and to the local community. Through this hands-on experience, students are engaged in the Science, Technology, Engineering and Mathematics (STEM) fields, and pushed toward STEM-related careers. From the first school contact in December, 2000 to the last school contact of FY 2007 (the 321st school to date), ARISS has continued to inspire the next generation of explorers…as only NASA can.

Organization

ARISS is an international working group, consisting of delegations from 9 countries including several countries in Europe as well as Japan, Russia, Canada, and the USA. The organization is run by volunteers from the national amateur radio organizations (American Radio Relay League (ARRL) in the U.S.) and the international AMSAT (Radio Amateur Satellite Corporation) organizations from each country. Since ARISS is international in scope, the team coordinates locally with their respective space agency (e.g. ESA, NASA, JAXA, CSA, and the Russian Space Agency) and as an international team through ARISS working group meetings, teleconferences and through electronic mail. The team brings approximately $5 million per year of in-kind support to the ISS program, primarily through technical and educational volunteer support to the schools, hardware development, and operations support.

During FY2007, the international team formed 67 partnerships with schools (grades K-12 and universities), NASA Explorer Schools (NES), Boy Scouts, Girl Scouts, museums and camps. Among those that collaborated with ARISS were the Manheim Museum in Germany, the 2007 Australian Jamboree, the National Air and Space Museum in Washington D.C., Challenger Learning Center of Lucas County in Oregon, Ohio, 21st. World Scout Jamboree in Chelmsford, United Kingdom, Gail Borden Public Library in Elgin, Illinois and Arnold Palmer Hospital for Children in Orlando, Florida.

Program Objectives

ARISS strives to meet NASA education goals of strengthening NASA's and the nation's future workforce through attracting and retaining students in STEM disciplines and engaging the general public in NASA's mission. The preparation for ARISS contacts exposes students, the general public, and the ISS crew members to amateur radio. Young people are then exposed to human spaceflight by direct contact with crew members onboard the ISS. Astronauts and cosmonauts benefit from these contacts as they speak to people who are not solely involved with their ISS mission, reducing feelings of isolation during their long stay in space. Opportunities exist for experimentation and for the evaluation of new technology as it relates to this program, and ARISS provides a contingency communications network for NASA and the ISS crew. The increase in public awareness of NASA and amateur radio benefits the next generation by promoting interest in the fields of science, technology and engineering and mathematics.

Educational Outreach

Elementary through Secondary Schools

ARISS provides a forum through which students are engaged and educated in STEM-related activities. Teachers employ NASA lesson plans and lithographs in their science and math curricula. Lessons culminate in an amateur radio contact with the ISS. During the past year, children at the elementary, middle and secondary levels, throughout the world, have benefited from this unique experience as demonstrated below.

- ARISS formed a partnership with the NASA Explorer School (NES) program. NES students from Kenneth J. Carberry Intermediate School in Emmett, Idaho, Toyon Elementary School in San Jose, California and Mitchell Elementary School, Ann Arbor, Michigan, participated in ARISS contacts in FY2007.

- Students from Romeo Elementary School in Dunnellon, Florida prepared for their ARISS contact by engaging in science and communications experiments. Students learned about radio waves, sound waves and communications and attended presentations and demonstrations given by members of the Silver Spring Radio Club. They used amateur radio to speak with others locally, nationally and internationally. The teacher who coordinated the contact received two grants which were used to purchase radio equipment, an antenna, a satellite tracking program and ARISS resource materials. During the ARISS contact activities, astronaut Joe Acaba, a former Dunnellon teacher, visited the school and gave several presentations on space.

- To prepare for their ARISS contact, members of Boulder Hill Elementary School Radio Club in Montgomery, Illinois built Morse code transmitters and crystal radio receivers. The club members, of which two thirds were girls, spoke to other hams over the radio and began to study for their amateur radio license exams. Approximately 600 students were present for the ARISS event.

- Astronaut Barbara Morgan participated in an ARISS contact with the McCall-Donnelly School District in McCall, Idaho during her STS-118 mission. The school district of approximately 900 students consisted of two high schools, one middle school, and two elementary schools. The event was aired live on NASA TV.

- The first Chinese school contact was performed with youth from Nanjing No. 3 High School in Nanjing, Jiangsu, China. ARISS Chairman Frank Bauer supported the event by giving via teleconference, a brief overview of ARISS prior to the contact. In addition to the 300 students who participated, over 60 local government officials attended the event. News of the contact was picked up by several radio stations, ten television stations and over thirty newspapers. Video was available on the internet. The extensive media coverage *reached over 100 million people!*

- Local Catalina and Green Valley Amateur Radio Clubs made donations of radio equipment to the Pueblo Magnet High School Amateur Radio Club in Tucson, Arizona, which was formed to involve students in math and science. Five students earned their amateur radio Technician licenses and one even upgraded to General class. Twenty-seven other members in the radio club will take their license exams by April 2008. The high school is registered with the American Radio Relay League as one of only 200 schools nationwide in the "Big Project" program. The Science, Art, Economics and Special Education departments were involved in an ARISS event this year which was attended by 1800 students. Student video and journalism teams put together a presentation about the radio club which now maintains a fully functional satellite station.

- Young women at the Sacred Hearts School in Honolulu, Hawaii continued to support the ARISS program by running the Hawaii ground station under the direction of their teacher and a local AMSAT volunteer.

- A contact was arranged for Sainte Marie, a primary school located in Suarlee, Belgium. An ARISS member familiarized the students with amateur radio and ESA candidate astronaut Vladimir Pletser presented space exploration videos on parabolic flight campaigns and Mars camps. This was the first ARISS contact with a school in the French speaking region of Belgium, Wallonia.

Higher Education

ARISS partnered with college and university students in STEM-related fields, giving them the chance to apply what they have learned in their classes to hands-on activities, furthering their interest and abilities in science and technology, and promoting STEM-related career opportunities. Over the past year, students at higher educational levels, throughout the world, have received benefits from this program as follows:

- Students and faculty at the Santa Rosa Jr. College in Santa Rosa, California were responsible for the set-up and operation of the ARISS ground station located there.

- Under the guidance of Dr. Pawel Kabacik, Assistant Professor at the Institute of Telecommunications and Acoustics Wroclaw University of Technology, an ARISS-Europe student team continued to develop the ARISS antennas for the ISS Columbus Module. These antennas were tested, flight certified and installed in October 2007. They will be delivered to the ISS on STS-122 in February 2008.

- Electrical engineering students at the College of New Jersey participated in the SuitSat-2 software defined radio hardware testing and development. The two Radio Amateur Satellite Corporation (AMSAT) members who taught this group of students received an invitation from the engineering department head to repeat the course in the fall of 2007.

- Two hundred students gathered in the radio shack at the Heidelberg University for Applied Sciences in Germany to experience an ARISS contact. The audio and video were linked to the university's main hall for others to observe the event.

- Russian students at the Kursk State Technical University spoke with Expedition 15 Commander Fyodor Yurchikhin on board the ISS via amateur radio.

- Puskás Tivadar Távközlési Technikum in Budapest Hungary participated in an ARISS event with Hungarian born space visitor Charles Simonyi.

Informal Education

The ARISS program supported education outside of the classroom. Eighteen contacts were performed with museums, Scouts, space camps, community centers, Challenger Learning Centers, planetariums and other informal educational groups.

- On May 5, 2007, AMSAT and ARISS joined in the celebration of Space Day at the National Air and Space Museum in Washington, D.C. The event included astronaut appearances, hands-on activities, and model rocket building. Local robotics teams demonstrated their projects with a robot petting zoo and visitors were

able to view the Orion Crew Exploration Vehicle. AMSAT and ARISS members manned an exhibition booth and an ARISS contact was scheduled with Sunita Williams, KD5PLB. Space Day draws approximately 10,000 visitors to the Air and Space Museum annually.

- AMSAT and ARISS exhibition booths were set up at the Smithsonian National Air and Space Museum as part of its Family Day, "Commemorating 50 Years in Space," which was held on September 29, 2007. The overall theme of the occasion was to celebrate at least one major event and object in the museum's collection for each decade of the space age. Youth attending the event used amateur radio to speak with astronaut Clay Anderson aboard the ISS. The event was sponsored by spaceflight participant Charles Simonyi who also participated in ARISS contacts during his flight on the ISS. Approximately 15,000 - 20,000 visitors attended.

- A successful ARISS contact was carried out with Scouts attending the Australian Scout Jamboree 2007 in Elmore, Victoria, Australia. Approximately thirteen thousand Scouts and eight thousand leaders from 53 countries attended the event.

- Scouts attending the 21st World Scout Jamboree in Chelmsford, England took part in an ARISS contact using the special event station, GB100J. Approximately 40,000 Scouts from 200 countries attended the jamboree which celebrated the 100th anniversary of scouting. Audio was broadcast on the jamboree FM radio station and was Web cast on the radio station's Web site.

- Gail Borden Public Library in Elgin, Illinois scheduled an ARISS contact during its multi-media educational exhibit, "SPACE: Dare to Dream." The exhibit was on display for four months, drawing 350,000 people of all ages. It encouraged the public to join the library's reading program, "Mission: Read." In addition to these exhibits, many special programs with presentations and hands-on activities were offered. Space videos and a slideshow of the crew and earth observation photos were shown on the day of the contact. The collaborative exhibit and program partners were Adler Planetarium, Chicago, IL; Fermilab, Batavia, IL; Planetary Studies Foundation, Galena, IL; Lizzadro Museum of Lapidary Art, Elmhurst, IL; NASA Glenn Research Center, Cleveland, OH; SciTech, Aurora, IL.

- Santa Rosa Junior College, in California, held its annual open house, "Day Under the Oaks." Demonstrations were provided to the public which included computer model building, planetarium shows and tours of the ARISS W6SRJ telebridge station. A robotics competition was also held. An ARISS contact was scheduled as an activity during this event which was witnessed by several hundred people. ARISS mentors handed out ARISS information packets to over forty teachers.

- Canadian high school students who attended the Manitoba Space Adventure Camp in Winnipeg participated in an ARISS contact as part of the Win-Cube Project. Win-Cube is a science and engineering project that involves students from ten Manitoba high schools in the design, construction, launch, and communication with a pico-satellite in low earth orbit. Licensed students took an active role in establishing and maintaining communication with the ISS.

- Long-term patients at the Arnold Palmer Hospital for Children in Orlando, Florida participated in an ARISS contact with Clay Anderson, KD5PLA. An ARISS team member gave a presentation on amateur radio and the ARISS program to the children and ARISS lithographs were distributed. The hospital provided a talk on the medical advancements made through space science which are now available due to NASA and its research. This was the first ARISS contact in a hospital setting.

- Approximately 58 boys, ages 6-18, from Cub Scout Packs 983, 977, 778, 997, Troop 993 and ham radio Explorer Post 599 in Maricopa, Arizona met to assemble two non-flight safety boxes for SuitSat-2. The Scouts also drew pictures to be included on the SuitSat-2 DVD. Afterwards, the older boys were taught how to solder and lace cables.

Public Outreach

ARISS inspired the public to explore science through its outreach efforts. Through presentations, papers, trade shows, amateur radio exhibits in museums and other public forums, and through ARISS participation in amateur radio events and activities, the public's interest in science has been advanced. Several examples of these items are described below.

- Public Relations

    - Announcements were made by the ARISS team and each school prior to and following each contact on the ARISS Web sites and through press releases. As a result, members of the community and members of the local, national, and in some cases international press attended each school contact. These events touched a worldwide public audience in the millions.

    - News items were posted to LM_NET, (a school Library Media listserv for school library media specialists) whenever an ARISS radio contact was scheduled in the U.S. during school hours.

    - American Radio Relay League (ARRL) covered ARISS school contacts and other ARISS related items in articles printed in its monthly journal (150,000 circulation), posted on the ARRL Web site (100,000 regular readers), and written in their e-newsletter (circulation 115,000).

- Japan Amateur Radio League (JARL) regularly carried articles on ARISS school contacts and other ARISS achievements.

- The Wireless Institute of Australia carried stories about local ARISS school contacts on its Web site, newsletters, and podcasts.

- A Saskatchewan native, responsible for the Radio Amateurs of Canada (RAC) educational program, publicized ARISS to Canadian schools and the press.

- AMSAT published ARISS news items in its *AMSAT Journal*, published bimonthly, and on its Web site.

- Presentations and Papers

  - Prior to each school contact, AMSAT mentors, ARISS volunteers and school students gave presentations on space, science education, and amateur radio to teachers, school staff, family members and the public in attendance.

  - Several ARISS presentations were given at the Dayton Hamvention 2007.
    - ARISS Chairman gave a presentation on "ARISS and Future SuitSat Missions" at the AMSAT forum.
    - Dr. Barry Cohen, K2JV, spoke at the Teachers' Workshop on "Events Leading up to the ARISS QSO (Contact) at School."
    - NASA astronaut Bill McArthur, KC5ACR, gave a talk on the ARISS contacts he participated in during his Expedition 12 mission.
    - ARISS Hardware Manager spoke on SSTV, "SuitSat 2, Not the Same Suit."
    - ARISS-U.S. delegate spoke on SuitSat-2 and related lesson plans.
    - An ARISS member gave a presentation on ARISS and education.

    The Dayton Hamvention is an internationally attended amateur radio convention that draws crowds of 25,000 annually.

  - NASA Marshall Space Flight Center engineer Don Hediger, who is also an amateur radio operator, gave a presentation on the ARISS program at the Huntsville Hamfest in Alabama. The event hosted the American Radio Relay League National Convention.

  - An ARRL member gave an amateur radio presentation to a college class at California State University, Fresno. His talk covered CubeSats, Student Space Exploration and Technology Initiative (SSETI) and ARISS, including the satellites SuitSat-1 and SuitSat-2.

  - The National Space Society sponsored the International Space Development Conference which was held May 24 – 28, 2007 in Addison, Texas. The event was held to document science on the ISS. ARISS Chairman Frank Bauer presented a paper, "ARISS---Inspiring Youth through Direct Connections with the ISS Crew."

- Four ARISS presentations were given at the 2007 Radio Amateur Satellite Corporation (AMSAT) Space Symposium held in Pittsburgh, Pennsylvania.
  - "ARISS Contact with the Arnold Palmer Hospital for Children," Dave Jordan, AA4KN.
  - "SuitSat-2," Lou McFadin, W5DID.
  - "Human Spaceflight, ARISS & Future SuitSat Missions," Frank Bauer, KA3HDO.
  - "Launching Dreams: The Long-Term Impact of SAREX & ARISS," Patricia Palazzolo, KB3NMS.

- Public Outreach Events and Activities

  - An aerospace museum at Alfonso Air Base in Brazil placed an amateur radio station in its ISS exhibit. The radio continues to monitor ARISS activities.

  - AMSAT-NA continued with its effort to have every board member attend an ARISS contact in the U.S.A., Canada or Australia, in order to promote the program and to provide a stronger support system within the AMSAT community. Several members have already attended.

  - Young Astronaut's Day workshop was held at Georgia's Museum of Aviation. The Middle Georgia Radio Association operated a special event station for the occasion, introducing youth to amateur radio including Amateur Radio on the ISS.

  - A terrestrial radio contact took place between astronaut Bill McArthur, KC5ACR, and students in South Africa to celebrate Youth Day. An ARISS member arranged the contact with undergraduates and high school radio club members who had just earned their ham licenses. The school headmaster was pleased with the outcome and plans to promote amateur radio as a major support subject at the school.

- Voice over the Internet Protocol

  - Work has continued in expanding the program's outreach to both students and the general public using Voice over the Internet Protocol (VoIP) technology which links the ISS to amateur radio over the internet. Internet Radio Linking Project (IRLP) and EchoLink have been successful in increasing the audience base of ARISS contacts as additional schools and individuals have tied into the audio made available through VoIP. Of the 67 ARISS school contacts that took place during FY2007, audio from 46 of those was fed into the IRLP or EchoLink servers.

Crew Operations

Crew members may use the ISS Ham equipment to speak to friends, family and the general public to help prevent feelings of isolation. The radio system may also be used for backup communications in the event there is an interruption in the prime ISS communications system.

- Space participant Charles Simonyi, KE7KDP, made several amateur radio contacts with ground stations in Hawaii and the U.S.A. northern west coast.

- Astronaut Thomas Reiter, DF4TR, connected with several ground stations in Norway, the Netherlands and the U.K.

- On Thursday, October 26, 2006, NASA asked the Amateur Radio on the International Space Station team to enable its contingency communications network due to ISS-Progress docking issues. There were some concerns that the Tracking and Data Relay Satellites System (TDRSS) coverage might be lost and NASA wanted to have solid communication coverage while they worked the issue. ARISS' station in Australia was ready within 15 minutes of the request as others around the globe began to bring up their stations. Although the network was not needed, it was the first time in the 6 year history of ARISS that the team was asked by NASA to bring up this contingency communication network. NASA was impressed with the ARISS team and its efforts.

Astronaut Training

The ARISS-U.S. team provides training sessions to astronauts to prepare them for their amateur radio licensing exams. They are given an overview on ARISS radio systems and school operations. A refresher course may be given prior to flight. ARISS-Russia also prepares the cosmonauts for their exams and trains the crews on ISS Ham hardware. Astronaut Timothy Kopra, KE5LUT, and spaceflight participant Charles Simonyi, KE7KDP, were licensed in FY2007. During this year, training on ARISS hardware and school operations was provided to Nicole Stott, KE5GJN, Tim Kopra, KE5LUT, Clay Anderson, KD5PLA, Fyodor Yurchikhin, RN3FI, Michael Barratt, KD5MIJ and ESA astronauts Christer Fuglesang, KE5CGR/SA0AFS and Paolo Nespoli, IZ0JPA.

New Initiatives

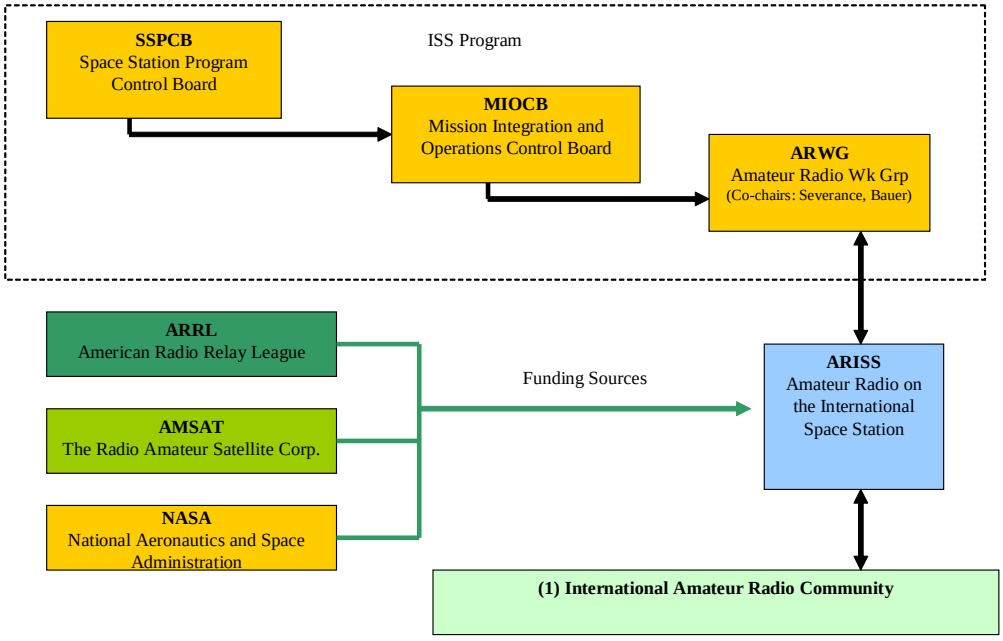
Digital Learning Network

Johnson Space Center is developing a module on the ARISS program for the Digital Learning Network (DLN). The module will incorporate ARISS lesson plans. Thousands of school children are reached through DLN each year.

ARWG Charter

ARISS is an international working group that is funded by NASA, the ARRL and AMSAT and receives in kind resources and support from ARRL, AMSAT and amateur radio operators world wide. An Amateur Radio Working Group (ARWG) charter has been written in order to formalize the multilateral agreement between all participating ARISS partners. ARWG is delegated from the Mission Integration and Operations Control Board (MIOCB) and chartered to coordinate the planning, development, integration and operation of amateur radio on the ISS. The ARISS Chairman and NASA OC7 Ops Planning and Amateur Radio Lead will co-chair ARWG and representatives will come from the space agencies JAXA, CSA,

ESA and Roscosmos. Other members will include cosmonaut and astronaut representatives and a Houston Support Group representative.



ARWG Related Board Structure

SuitSat-2

ARISS will participate in a second SuitSat project to commemorate several anniversaries: Sputnik's 50th, Korolev's 100th birthday, Tsiolkovsky's 150th birthday, and the 125th anniversary of Robert Goddard's birth. SuitSat-2 is designed to have greater capabilities than its predecessor, increasing opportunities for student involvement and experimentation. The Russians will provide a battery and a surplus Orlan spacesuit to house the amateur radio system. The U.S. team will supply the internal housekeeping unit (IHU), the software defined radio (SDR), antennas, cameras and solar panels. There will be four ports available for student experiments. SuitSat-2 will send voice greetings in several languages recorded by students and it will send via Morse code a list of callsigns of those who have contributed to amateur radio in space. Slow Scan Television (SSTV) images and telemetry will be transmitted to Earth. Students will provide creative work and technical documents to be included on a DVD which will fly on SuitSat-2. College students have

already been involved with development and testing of the software defined radio and Scouts have participated in the assembly of two non-flight SuitSat-2 safety boxes. Lesson plans have been written for grades K-3, 4-6, and 7-12. Older students may participate in SuitSat activities that will be posted on the SuitSat Web site. SuitSat-2 is expected to launch in late 2008 and to be deployed on a subsequent spacewalk.

ARISS International Face to Face Meetings

Purpose of Face-to-Face Meetings

Because ARISS is managed by an international team of volunteers, and because the ARISS program covers a diverse and large number of aspects such as current and future hardware, school and community education, publicity, operations with crew, crew support, (and so on), the volunteers meet as a team once each month on a teleconference call. Each of the 5 major ARISS committees that make up the entire team also meet among themselves on a weekly, monthly, or bi-monthly basis. Because the ARISS Team members come from many different cultures, the team learned that in order to interface effectively, we needed to hold an annual international delegate face-to-face meeting.

International delegate meeting agendas cover a broad array of items that are voted on after full discussions based on each country's point of view. The 2006 meeting was held in San Francisco, California on October 9 – 10.

Details from the Most Recent ARISS International Partner Meeting

As reported above, the ARISS Meeting agenda covers a diverse and large number of aspects, including school and community education, on-orbit and future hardware, publicity, operations with crew, crew support, etc.

The ARISS Team is made up of 5 regions representing the 5 primary space agencies (U.S., Canada, Russia, Europe and Japan). ARISS radio activity for youths is divided equally between these regions, and at ARISS meetings, regions report on their school successes. Each region gave an update on its activities. Bill McArthur, KC5ACR, was present and the team thanked him for his participation in a record number of contacts during Expedition 12.

Cindy McArthur from the NASA JSC Education Office was also present to learn more about the program and to share her experience with Downlinks. The Teaching from Space Office will help ARISS with funding and with expanding our educational outreach.

The Russian team indicated that their cosmonaut will soon be required to participate in three contacts per month. As they are still lining up schools, it was suggested that the cosmonaut participate in some contacts with U.S. schools to help alleviate the U.S. backlog.

Other topics reported at the face-to-face meeting included:

- Progress on the Columbus Module antennas and radio system.
- Kenwood radio system and reprogramming efforts.
- SSTV status.
- FT-817 HF radio will replace the FT-100 in a future flight.

- Discussion on planning to use our worldwide team for the Exploration *(Moon, Mars and Beyond)* Initiative.
- SuitSat-2 project
- Next ARISS International Meeting to be held in Moscow, Russia (currently planned for June 2008).

Technical Interchange Meetings

On November 6 – 10, 2006, a Spaceflight Training Division Technical Interchange Meeting was held at Johnson Space Center. ARISS members and representatives from Energia, and the Gagarin Cosmonaut Training Center (GCTC) attended. Roles and responsibilities of each group in training ISS crew members were defined.

Amateur Radio on the International Space Station team members met in Houston for a Technical Interchange Meeting (TIM) on July 9 – 13, 2007. The team discussed the development and status of the ARWG charter, the Columbus Module L and S band patch antennas and radio frequencies to be used in the future. The team acknowledged that crew time and volume on the ISS are at a premium. The Ericsson radio in the FGB was stowed in order to make room for another experiment and the team now needs to look for an opportunity to have the radio reinstalled. It was decided that future radio systems need to be as autonomous as possible. Options on how to restore the Kenwood radio to its launch configuration were also discussed and uploading the Memory Control Program (MCP) software for a reload was considered.

The design of SuitSat-2 was also covered. SuitSat-2 will commemorate the 150th anniversary of Tsiolkovsky's birth as its primary mission, but it will also serve as a test bed for testing new systems which are planned for future amateur radio satellites. SuitSat-2 components were discussed including:

- Selection of cameras to be used
- Installation of the switch, camera, antenna mounting and internal electronic boxes and batteries, solar panels and experiments
- Cables
- Integration and end to end testing
- Safety interlock system, safety documentation and certification
- Delivery method of U.S. components to Russia
- Schedule – delivery dates, launch dates, EVA for deployment
- Education opportunities – CW (Morse code) callsigns, school CD Rom and voice greetings, experiments

Program Evaluation/ Outcomes/Continuity

Teachers evaluate the ARISS program after their contact with the ISS by submitting a NASA Education Evaluation Information System (NEEIS) form. Additionally, input obtained from crew debriefs is taken into consideration for program improvement. Awards in excellence given to ARISS members are also an indicator of the program quality. Students and teachers continuing their education in fields related to the ARISS program, schools which set up radio

stations or continue on with related technologies, and remarks made by those involved with the program can provide necessary feedback to improve and refine the program. The items listed below are indicators of this program's success.

- Stephanie Radcliff experienced an ARISS contact as a student at Daviess County High School (DCHS) in Owensboro, Kentucky in May 2001. Today she is a graduate of Embry-Riddle University, and holds a degree in the aerospace field. She has applied and hopes to be accepted for astronaut training. Harold Wilson, the coordinating teacher of the DCHS-ARISS contact, remarked that it was the ARISS contact which inspired Stephanie to pursue this career.

- "We are also working with the Schenectady Amateur Radio Association and our after-school program to begin a ham radio club for students. Thanks for making this [contact] possible for us." –Rita Moore, Central Park Middle School, NES, Schenectady, New York

- Student SAREX volunteer, Mike Sufana, received his Aerospace Engineering degree and is now working at Northrop Grumman.

- SAREX student, Melissa Mladnic, from Jerling Jr. High, is attending Purdue University School of Aerospace Engineering with aspirations of becoming an astronaut.

- A student who participated in a SAREX contact with astronaut Ken Cameron in 1994 is now an Air Force Academy graduate. She dreams of becoming an astronaut and attributes much of her interest in flying to her participation in that contact years ago. As a little girl, she was able to ask her question, "How does a fish swim in space?" Today she is a pilot and she continues her flight training on fighter jets.

- "The most valuable aspect [of the contact] was to help my students make a personal connection to the space program and to consider that a career in space aeronautics is a viable option for them. It humanized the space program and made it come alive as opposed to my students just thinking of it as something that is performed by scientists in white lab coats." – Jan French, teacher, Cincinnati Country Day School, Cincinnati, Ohio

- "As the control op for W9BHB yesterday at Boulder Hill I can't express enough thanks to the ARISS program. In the short time since the contact, I have been phoned and e-mailed and talked to by just about every adult who was present. We met as a club after school and the kids were still in shock. A student I don't know, I think he was a 2nd grader came up to me in the hallway and handed me a folded piece of blue construction paper, I opened it and inside was a pencil drawing of the antennas on the roof, a bunch of wire a table with a stick figure holding a mic reaching out to another stick

figure with what looks to be the ISS at the top of the page. I brought that home and framed it, it's now hanging proudly in my shack. Parents of students, administrators, political figures - Each of them said the same thing: "When Suni's voice came through the static for the first time, I couldn't believe it, tears started streaming down my face" it was a very unique and emotional experience for those 700 who gathered to join us for this moment. On behalf of the teachers and students of Club Station W9BHB and Boulder Hill Elementary School our sincere thanks and appreciation go to ARISS and to Suni Williams!" - John Spasojevich, W9BHB

- A teacher at East Elementary School in Wisconsin left his ham radio turned on in the classroom in case any contacts with the Space Station might be heard. He picked up on an ARISS school contact which grabbed his students' attention. One of the students participating in the contact asked how fast the ISS traveled and when Sunita gave the answer "over 17,000 mph," the class made a collective "Ooooh" sound! Afterwards, the teacher took the opportunity to teach a mini-lesson on geography and math using the information presented in that short ARISS contact. The students have repeatedly asked him, "When can we talk to the astronauts?" He has since filled out an application for an ARISS contact.

- The United Kingdom's television station, ITV1, aired the Pride of Britain Awards in which the Teacher of the Year award was given to Head Teacher Linda Davies. Davies was the teacher who coordinated the first ARISS contact in Britain for her classes at Wiltshire's Neston Primary School and was commended for her work, which inspired students and promoted science at the school.

- The Japan Amateur Radio League (JARL) issued the All Japan Districts award to the International Space Station, NA1SS. Astronauts using the station's callsign NA1SS have contacted a school in all ten of Japan's amateur radio call areas.

- ARISS member Tony Hutchison, VK5ZAI, was named to the Wireless Institute of Australia (WIA) board position of Australian National Coordinator for ARISS. Tony had recently given a talk on the ARISS education program to the board members.

- M. L. King Academy in Mount Clemens, Michigan experienced an ARISS contact with Clay Anderson, KD5PLA. The school board director was one of approximately 350 who gathered to watch the contact. He is now encouraging other schools to submit applications to ARISS.

- In April 2006, Escola Americana do Rio de Janeiro experienced an ARISS contact with Marcos Pontes, PY0AEB. As a direct result of that contact, several students became interested in learning more about amateur radio. The Amateur Radio and Space Experiment (AMRASE) (a Brazilian non-governmental organization dedicated to developing technical programs for use in schools) team developed a special workshop for the students which covered radio communications, antenna systems, space communication by satellites and the amateur

radio system on the International Space Station. Ten students studied and prepared to take their amateur radio license exams.

Future ARISS Projects

Exploration (Moon Mars and Beyond) Initiative

In March 2006, Amateur Radio operators from AMSAT Germany tracked and received data from Voyager 1 using the 20m antenna at Bochum at a distance of 14.7 billion km. Its data was checked and verified against data from the Deep Space Network station. This was good news for the Amateur Radio community as NASA is currently pursuing an exploration of space, “to the Moon, Mars, and Beyond.” ARISS is considering educational payloads that may be included on these missions. A repeater on the moon, a remote amateur television, and a Mars telecommunications satellite are such possible payloads. These payloads will generate interest among students, encouraging participation in amateur radio projects and in space, science and technology.

Appendix

Appendix A NEEIS FY2007 Final Program Report

Appendix B ARISS Metrics 2007
U.S. School Contacts FY2007, Diversity by State

Appendix C ARISS Achievements Calendar Year 2007

Appendix D ARISS Roles and Responsibilities

Appendix E ARISS---Inspiring Youth through Direct Connections with the ISS Crew, Frank Bauer, et.al.

Appendix F School Contact Maps

Map, ARISS-USA Radio Contacts, FY2007

Map, ARISS-USA Radio Contacts through FY2007

Map, ARISS-International Radio Contacts through FY2007

Appendix A

NEEIS FY2007 Final Program Report

FY2007 FINAL PROGRAM REPORT

General Information

Program Title: Amateur Radio on ISS (ARISS)

Program Manager:
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Report Submission Date: 06-Nov-2007

Program Information

1. Primary Program Type:

(X) NASA-Wide () Center-Unique () Directorate:

Directorate:
() Exploration Systems
(X) Space Operations
() Science
() Aeronautics Research
() No Directorate

() Partnership () Multi-Center

2. Project Type:

(X) Elementary and Secondary Participation
() Higher Education Capability
() Under-represented and Underserved Participation
() e-Education
() Informal

3. Project Focus:

() Teacher/Faculty Preparation and Enhancemen
(X) Student Support
() Curriculum Support and Dissemination
() Education Technology
() State Based Improvement
() Research and Development

4. Goals & Objectives :

Goal 6:	(X) 6.1	(X) 6.2	(X) 6.3	(X) 6.4
Goal 7:	() 7.1	(X) 7.2	() 7.3	

5. Program Duration :

(X) Short Event (A few hours only.)
(X) One time Only
() Multiple Meetings with the Same Participants
Number of Meetings:
() Short Intensive Program (less than 4 days)
() 7-13 Day Intensive Program
() 2 Week Intensive Program
() 3 Week Intensive Program
() 4 Week Intensive Program
() 5-8 Week Intensive Program
() 9-10 Week Intensive Program
Total number of Events/Workshops lasting between 1 and 10 weeks long offered :
() Extended Program Up To One Year
() Extended Program More Than One Year
Number of Years :

6. Program Content :

(X) Aeronautics/Aerospace	(X) Astronomy
(X) Astrophysics	() Bioengineering
(X) Biology	() Business
(X) Chemistry	(X) Computers/Computer Science
(X) Earth Sciences	(X) Education
(X) Engineering	(X) Environmental Sciences
(X) Geography	(X) Life Sciences
() Materials Sciences	(X) Mathematics
(X) Physical Sciences	(X) Physics
() Psychology	(X) Social Sciences
(X) Other	

Program Details Information

1. Applicants : 0

2. Location of Program Activities :

(X) NASA Center(s)	(X) Museum/Planetarium(s)
(X) University Campus(es)	() Industry or Private Sector Facilities
(X) Community College Campus	(X) Elementary/Middle/High School(s)
(X) Community Facilities	() Other

3. Program Activities Techniques and Resources :

(X) Computer Training	(X) Mentoring (K-12 or College Students)
(X) Demonstrations	(X) Movies/Video
(X) Group Discussions	(X) Problem Solving Activities
(X) Hands On Activities	(X) Research Analysis
(X) Field Trips	(X) Team Activities/Projects
(X) Independent Study	(X) Textbooks
(X) Interdisciplinary Activities	(X) Tours
(X) Internet/Communications Technology Training Sessions	() Video Teleconferences
(X) Investigation	() Working Group
(X) Laboratory	() Other
(X) Lectures	

4. Standards (Was support provided for any of the following standards?):

(X) National Mathematics Standards	(X) National Science Standards
(X) National Geography Standards	(X) National Technology Standards
(X) State Frameworks	(X) Local Frameworks
() Other	() Not Applicable

5. Participant Products (By end of the program, the participants prepared one or more of the following.):

(X) Action Plan	(X) Research Proposal
(X) Article for Publication	Report
(X) Presentation for a Conference	(X) Oral
(X) Course Outline/Revision	(X) Written
(X) Course Problem Set/Activity	() Software
(X) Drawing or Art	() Teacher's Manual

(X) Journal/Lab Workbook

Lesson Plans using:

(X) Experienced-Based Activity

(X) Scientific/Engineering Methods of Inquiry

(X) Technology

(X) Interdisciplinary Approaches

(X) NASA Materials

(X) Multimedia Product (includes video)

(X) Physical Model or Product

(X) Portfolio

(X) Project Design

(X) Research Paper

Teaching/Learning Activity using:

()Experienced-Based Activity

() Scientific/Engineering Methods of Inquiry

() Technology

() Interdisciplinary Approaches

() NASA Materials

() Technical Paper for Publication

(X) Educational Video

() No Product Required

() Other

6. Program Content :

(X) Science (X) Mathematics (X) Engineering (X) Technology () Other

7. Networking and Electronic Resources :

Does the Program provide some means to promote ongoing communications among participants after the Program is over?

(X) Yes () No () Not Applicable

Did the Program introduce participants to NASA On-line Resources?

(X) Yes () No () Not Applicable

8. Multiplier Effect :

Did you take any actions to encourage and/or facilitate a "multiplier" effect to extend the benefits of the Program beyond participants once the Program is over?

(X) Yes () No () Not Applicable

9. Underrepresentated Groups :

Did you take any actions to make your Program announcements and information available to members of various populations which are generally underrepresentated?

(X) Yes () No () Not Applicable

10. Funded (The program funded the following for the participants.) :

() Course fees/Credits Paid/CEU
() Expenses/Per Diem
() Fellowship/Scholarship
() Grant
(X) Materials, books to be kept by the participant
() Membership in a Professional Organization
() Stipend/Honorarium
() Other

Resource Details Information

1. Funding :

	Total
Funds from NASA HQ Codes (Not Ed):	$0
Funds from other NASA Centers:	$0
Funds from your Center:	$0
Funds from other Federal Agencies:	$0
Funds from State Government Agencies:	$0
Funds from Contractors/Grantees (Not NASA funds):	$0
Funds from Local Organizations:	$0
Funds from Educational Organizations/Institutions:	$0
Other:	$0
Total Funding:	$0

2. Staffing :

() This Program is primarily managed by a contractor/grantee

() This Program is primarily managed by NASAstaff.

Number of NASA Civil Servants involved :

	Total
Administrative	0
Astronauts	0
Audio/Video Specialists	0
Computer Specialists	0
Education Specialists	0
Engineers	0
ERC Staff	0
On-line Resources Specialists	0
Pilots	0
Program/Project Managers	0
Scientists	0
Support Staff	0
University Affairs Officers	0
Total NASA Civil Servants:	0

TOTAL NUMBER OF PRESENTATIONS: 0
TOTAL NUMBER OF PRESENTERS: 0

Total number of NASA presenters: 0
Total number of contractor presenters: 0
NUMBER OF RETIREES (NON-NASA AND/OR NASA): 0

3. Partnerships/Collaborations - Rollup :

	Total
Other NASA HQ Program Office Partnerships/Collaborations:	0
K-12 School Partnerships/Collaborations:	0
K-12 School District Partnerships/Collaborations:	0
Professional Society Partnerships/Collaborations:	0
State Government Partnerships/Collaborations:	0
Education Resource Center Partnerships/Collaborations:	0
Community College Partnerships/Collaborations:	0
Total Partnerships/Collaborations:	0

(not including the ED Branch or PAO if it is separate from the Education Office)	
Other NASA HQ Program Office Partnerships/Collaborations:	0
K-12 School Partnerships/Collaborations:	0
K-12 School District Partnerships/Collaborations:	0
Professional Society Partnerships/Collaborations:	0
State Government Partnerships/Collaborations:	0
Education Resource Center Partnerships/Collaborations:	0
Community College Partnerships/Collaborations:	0
Total Partnerships/Collaborations:	0

4. Fellowships and Scholarships :

	Total
Students 9-12:	0
Undergraduate Students:	0
Graduate Students:	0
Post Doc:	0
Other:	0
Total Fellowships and Scholarships:	0

5. NASA Materials Distributed - Rollup :

	Total
Total Number of NASA educational materials (videos, publications, wall posters,--not patches, pencils, bookmarks, etc.) distributed:	0
Number of NASA individual educational materials demonstrated by presenter(s) during the Program:	0

6. NASA Facilities :

() Laboratories

() Launch Pad

() Maintenance Facilities

() Mockup Facilities

() Spacecraft Display

() Test Stands

() Hanger

() Laboratories

() Launch Pad

() Maintenance Facilities

() Mockup Facilities

() Spacecraft Display

() Test Stands

() Wind Tunnel

Participant Counts Information

A. DIRECT PARTICIPANTS:

1. Teachers:

	Physical Presence Number	Distance Learning Number
ENTER THE TOTAL NUMBER OF ALL K-12 AND IN-SERVICE TEACHERS:	**894**	**339**

	Physical Presence Number	Distance Learning Number
Teachers teaching grades K-4:	339	94
Teachers teaching grades 5-8:	1,338	162
Teachers teaching grades 9-12:	220	45
In-Service Teachers:	0	0

2. Higher Education Faculty:

	Physical Presence Number	Distance Learning Number
Community College:	33	350
4 year undergraduate:	67	0
4 year undergraduate/graduate:	49	32
Total Faculty:	149	382

3. Students:

	Physical Presence Number	Distance Learning Number
K-4:	4,534	871
5-8:	4,030	11,101
9-12:	2,322	1,075
Community College:	200	0
4 year undergraduate:	126	300
4 year undergraduate/graduate:	21	0
*Pre-Service Teachers:	3	0
Post Doctoral:	13	0
Total Students:	11,246	13,347

**The "Preservice Teachers" are not included in any totals. It is assumed that these participants will be reported under some other category e.g. 'Undergraduate Students', etc.*

4. Additional Participants:

	Physical Presence Number	Distance Learning Number
Administrators:	302	14
Civic Group:	369	0
Education Specialists:	241	12
Parents:	1,284	100
Professional:	227	0
Other:	325	0
Total Additional Participants:	2,748	126

TOTAL OF ALL DIRECT PARTICIPANTS: 29,231
(From A) (System Generated)

B. EDUCATION COMMUNITY PARTICIPANTS:

Higher Ed Faculty	211	0
Higher Ed Students	127	0
Other (Administrators, Educators and Students where the academic level is not known,Parents, etc.)	400	0

K-12 Students	71,740	520
Higher Ed Faculty	211	0
Higher Ed Students	127	0
Other (Administrators, Educators and Students where the academic level is not known,Parents, etc.)	400	0
Total Education Community:	**72,888**	**552**

TOTAL OF ALL EDUCATION COMMUNITY PARTICIPANTS: 73,440
(From B) (System Generated)

C. GENERAL PUBLIC/INFORMATIONAL OUTREACH:

	Participants (number)
General Public At Lectures, Tours, Conferences/conventions, museums/booths/displays, etc.	3,373
Estimated Newspaper/Magazine Audiences	64,356,605
Estimated TV/Radio Broadcast Audiences	217,826,149
Estimated CD-Rom Users	4,632
Web Audiences: Unique IP Addresses (*not included in totals below)	102,007,505
Other:	5,815
Total Public/Media:	**282,196,574**

TOTAL OF ALL OUTREACH PARTICIPANTS: 282,196,574
(From C) (System Generated)

TOTAL OF ALL PARTICIPANTS: 102,671
(From A & B) (System Generated)

GRAND TOTAL OF ALL PARTICIPANTS: 282,299,245
(System Generated)

Appendix B

ARISS Metrics FY2007

Total number of school contacts	67
Contact audio on VoIP/Web cast	46
International contacts	33
U.S. school contacts	34
Total rural school contacts	15
U.S. rural school contacts	8
NASA Explorer Schools	3
Title 1 schools	7
Informal education contacts	18

ARISS - U.S. School Contacts FY2007
Diversity by State

School or Event	City, State	Enrollment	% Caucasian	% African American	% Hispanic	% Asian	% Multiracial	% American Indian or Native Alaskan	% Economically disadvantaged	% Special Ed or IEP	% Limited English
Alaska (1st contact in 2007)											
Challenger Learning Center	Kenai, Alaska	50									
Arizona											
Pueblo Magnet High School (Title 1)	Tucson, Arizona	1964	5	3	87	<1		4	80		18
California											
Dilworth Elementary School	San Jose, California	456	14	<1	<1	84			2		13
Mission Viejo High School	Mission Viejo, California	2997	74	2	16	8		<1	6		3
Santa Rosa Junior College Open House	Santa Rosa, California	200									
Toyon Elementary School NES (Title 1)	San Jose, California	467	13	5	44	29	9	<1	32		40
District of Columbia											
Space Day 2007 National Air and Space Museum	Washington, D.C.										
Family Day National Air and Space Museum	Washington, D.C.	1000									
Florida											
Romeo Elementary School (Title 1)	Dunnellon, Florida	825	70	3	21		5	<1	67	14	16
Arnold Palmer Hospital	Orlando, FL	20									
Idaho											
Kenneth J. Carberry Intermediate NES (Title 1)	Emmett, Idaho	401	86	1	11	1		<1	56		

ARISS - U.S. School Contacts FY2007
Diversity by State

School or Event	City, State	Enrollment	% Caucasian	% African American	% Hispanic	% Asian	% Multiracial	% American Indian or Native Alaskan	% Economically disadvantaged	% Special Ed or IEP	% Limited English
McCall-Donnelly School District	McCall, Idaho	900									
Illinois											
Northlawn Jr.HS/ St. Anthony Schools	Streator, Illinois	624/243	81/92	5 & 3	12 & 5		2 & 0		49 & 0		1
Boulder Hill Elementary School (Title 1)	Montgomery, Illinois	517	69	5	21	4		<1	13		6
Christian Life Elementary School	Rockford, Illinois	1285	82	11	3	4					
Gail Borden Public Library	Elgin, Illinois										
Michigan											
M.L. King Academy (Title 1)	Mount Clemens, Michigan	360	40	55	<1	<1	3	<1	83		
Mitchell Elementary School NES	Ann Arbor, Michigan	268	47	29	4	8	12	<1	39		
Nebraska **(1st contact in 2007)**											
Winnebago Public School (Title 1)	Winnebago, Nebraska	462	1					99	81		
Ashland Greenwood H.S.	Ashland, Nebraska	260	96		2	2			20		
New Mexico											
Sunset Mesa Schools	Albuquerque, New Mexico	453	83	1	8	6		<1			
New York											
Sherman Elementary School	Henrietta, New York	479	77	11	4	7		<1	19	6	4
East Aurora Middle School	East Aurora, New York	491	98	<1	1	<1			5	9	2

ARISS - U.S. School Contacts FY2007
Diversity by State

School or Event	City, State	Enrollment	% Caucasian	% African American	% Hispanic	% Asian	% Multiracial	% American Indian or Native Alaskan	% Economically disadvantaged	% Special Ed or IEP	% Limited English
Richmond Hill Community Center	Queens, New York	50									
Ohio											
University School	Shaker Heights, Ohio	477	86	8	<1	6					
Fairborn High School	Fairborn, Ohio	1662	84	7	1	3	4	<1	23	14	
Challenger Learning Center of Lucas County	Oregon, Ohio	80									
Texas											
Teacher to Teacher Workshop	Houston, Texas	300									
Westbrook Intermediate School	Clear Creek, Texas	1245	49	17	19	15		<1	22	9	2
Goforth Elementary School	League City, Texas	714	74	8	14	4			25	12	4
Virginia											
Virginia Run Elementary School	Centreville, Virginia	928	82	2	4	9		<1	2		
Cedar Point Elementary School	Bristow, Virginia	1148	76	8	6	6		<1	3		
Kingston Elementary School	Virginia Beach, Virginia	566	91	3	1	3		<1	5		
Washington											
Redmond High School	Redmond, Washington	1514	79	3	6	11	<1	<1	9		

Appendix C
ARISS Achievements Calendar Year 2007

ARISS Achievements
Calendar Year 2007

The following is an overview of the accomplishments that ARISS achieved during the 2007 calendar year as of October 31, 2007.

2007 school contacts - **74** (includes 13 school contacts with visiting crew members Simonyi, Morgan, Shukor and Nespoli)

Total schools to date- **333** (ARISS contact #300 reached in May 2007**)**

2007 Individuals with 20+ contacts in a single flight - **2** (Suni Williams and Clay Anderson)

2007 school contact countries - **16** (Australia, USA, Canada, Japan, India, Portugal, Belgium, Netherlands, Hungary, Russia, Italy, Germany, Spain, United Kingdom, China and Malaysia)

2007 new school contact countries - **5** (Malaysia, China, Hungary, Portugal and India)

Total school contact countries to date - **30** (Australia, Belgium, Brazil, Canada, Finland, France, Germany, Greece, Hungary, India, Ireland, Israel, Italy, Japan, Kuwait, Malaysia, Netherlands, P. R. China, Poland, Portugal, Russia, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, United Kingdom and USA)

For those who like statistics:
22.2 percent of the schools contacted to date were done in 2007
53.3 percent of countries contacted to date were contacted in 2007
1.68 was the average number of school contacts each week from Jan 1- Nov 1 2007 (44 weeks)
It took 31 months to reach contact #100, 16 months to reach contact #200 and 17 months to reach contact #300

From 2001-2007, the average number of contacts is 47.43.
From 2001-2006, the average number of contacts is 43.00.
From 2001-2005, the average number of contacts is 42.20.
From 2001-2004, the average number of contacts is 39.00.
From 2001-2003, the average number of contacts is 40.33
From 2001-2002, the average number of contacts is 41.00

Where the 2007 operations appear in the records:
Individuals with 20+ contacts in a single flight.
1) Bill McArthur - 37
2) Suni Williams - 33
3) Leroy Chiao - 23

4) Frank Culbertson - 22
5) Clay Anderson - 21

Yearly totals

2000	1
2001	42
2002	40
2003	39
2004	35
2005	55
2006	47
2007	**74** **(Most EVER!)**

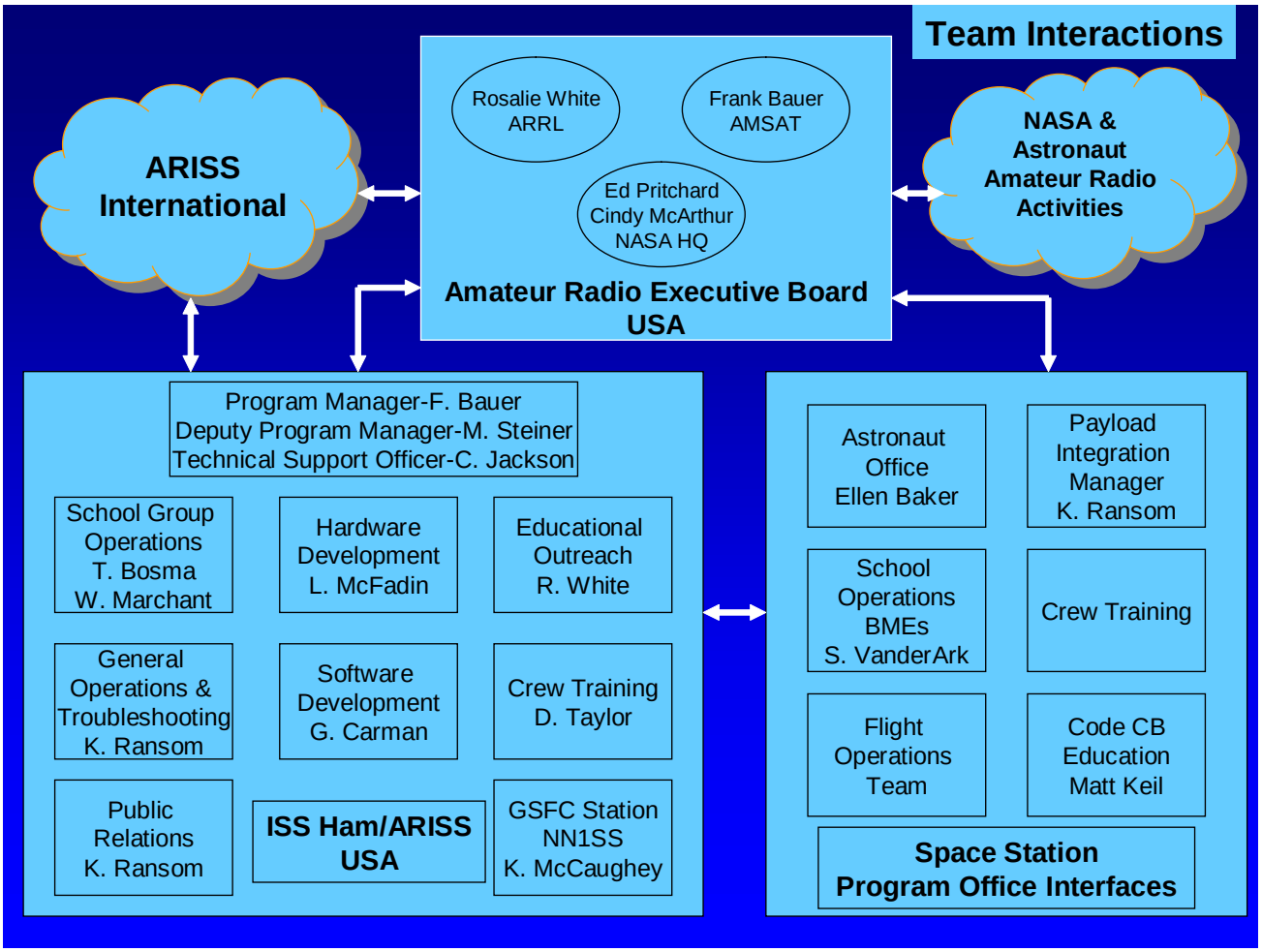
Number of school contacts by Expedition
(Rank order)

Rank	Exp	Total schools	
1	**15**	**39**	**(Most EVER!)**
2	12	38	
3	**14***	**25**	
4	10	23	
5	03	22	
6(t)	06	18	
6(t)	07	18	
6(t)	11	18	
9(t)	04	17	
9(t)	13	17	
11	09	15	
12(t)	02	14	
12(t)	05	14	
14	08	13	
15	01	07	
16	16	01	

*Exp 14 was from 2006-2007 with 20 contacts occurring in 2007

Appendix D

ARISS Roles and Responsibilities



Appendix E

ARISS---Inspiring Youth through Direct Connections with the ISS Crew

Frank H. Bauer, KA3HDO; Rosalie White, K1STO; Mark Steiner, K3MS;
and Carol Jackson, KB3LKI

ARISS---Inspiring Youth through Direct Connections with the ISS Crew

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Introduction

Amateur Radio on the International Space Station (ARISS) represents the first and longest continuous operating educational outreach program to fly on the International Space Station (ISS). ARISS is sponsored by NASA, many international space agencies, and several international amateur radio societies. Its primary purpose is to allow students engaged in a science and technology curriculum to speak with an astronaut orbiting the Earth on the International Space Station. Using amateur (ham) radio, the students ask questions about life in space or other space-related topics. Students fully participate in the ARISS contact by helping set up an amateur radio ground station at the school and then using that station to talk directly with the on-board crew member for approximately ten minutes, the time of an ISS overhead pass.

Preparation for the experience motivates the children to learn about radio waves, space technology, science, geography and the space environment. In many cases, the students help write press releases and give presentations on the contact to their fellow students and to the local community. Through this hands-on, grass-roots experience, students are engaged and educated in the Science, Technology, Engineering and Mathematics (STEM) fields, and are inspired to pursue STEM-related careers choices.

Approximately 15,000 students are touched directly by an ARISS contact each year. Tens of millions from the general public witness the contact either directly or through the news media. From the first school contact in December, 2000 to the 276th school to date, ARISS has inspired the next generation of explorers…as only NASA can!

Organization

ARISS is an international working group, consisting of delegations from 9 countries including several countries in Europe as well as Japan, Russia, Canada, and the USA. The organization is run almost entirely by volunteers from the national amateur radio organizations (ARRL in the U.S.) and the international AMSAT (Radio Amateur Satellite Corporation) organizations from each country. Since ARISS is international in scope, the team coordinates locally with their respective space agency (e.g. ESA, NASA, JAXA, CSA, and the Russian Space Agency) and as an international team through ARISS working group meetings, teleconferences and through electronic mail. The team brings approximately $5 million per year of in-kind support to the ISS program, primarily through technical and educational volunteer support to the schools, hardware development, and operations support.

In 2006 alone, ARISS formed 60 partnerships with schools (K-12 and universities), NASA Explorer Schools (NES), Boy and Girl Scouts, and with museums and camps such as the Cosmos Centre in Charleville, Australia, Discover Engineering Family Day held in Washington D.C., the European Space Agency Space Camp in Patras, Greece, and the Kuwait Scientific Center, Kuwait.

History Of Amateur Radio In Space

Amateur radio has had a significant human presence in space starting with a flight on-board the space shuttle Columbia on the STS-9 mission late in 1983. At that time, astronaut Owen Garriott, W5LFL, provided an unprecedented level of excitement in the amateur radio community by talking with ham radio operators on the ground using a specially developed VHF FM ham radio transceiver.

These modest beginnings 24 years ago led to frequent school group contacts with the astronauts on-board 25 space shuttle missions in the mid-1980's and during most of the 1990's as part of the US-led Shuttle Amateur Radio Experiment (SAREX) project. An internationally-based team, that included the U.S. SAREX team, developed ham radio equipment and performed school contacts with U.S. astronauts on-board the Russian Space Station Mir in the late 1990's. As the international space agencies moved their operations to the ISS, the international ham radio community developed equipment for operations on the ISS. Starting in November 2000, just 2 weeks after the first crew arrived, amateur radio operations were started on ISS. Since then, nearly continuous operation of the ham radio system on the ISS has been performed through the ARISS international volunteer team.

This internationally-based team pioneered several new and exciting communications capabilities on U.S. and Russian-based human spaceflight vehicles. Some of their accomplishments include:

•The first human tended amateur radio in space (1983)

•The first communications between astronauts and people outside official NASA channels (1983)

•The first pictures uplinked and downlinked to the Space Shuttle (1985)
•The first astronaut-student interviews (1990)
•The first computer-to-computer e-mails from the Shuttle (1990)
•The first television uplink to the Shuttle (1991)
•The first backup communications during a NASA satellite (TDRSS) outage (1992)
•The first Spacesuit satellite—SuitSat-1/Radioskaf deployed from ISS (2006)
•All 14 ISS expedition crews using the ARISS radio systems to conduct thousands of interviews with school students and thousands of contacts with ham radio operators around the world (2000-2007)

ARISS Station Equipment and Location

The ARISS ham radio equipment resides in two locations inside the ISS and several locations outside the ISS. Ham radio operations are primarily conducted inside the Functional Cargo Block (FGB), named Zarya and the Russian Service Module, named Zvezda. To date, these operations include radio communications in the VHF and UHF frequency bands. To support multi-mode, multi-operation contacts on ISS, four ham radio antennas were installed around the periphery of the Russian Service Module. The current equipment on-board supports voice operations, Instant Messenger-type e-mail and picture uplink and downlink using a technique called Slow Scan Television.

The ARISS team also received permission to install amateur radio antennas on the Columbus Module, the European Space Laboratory. Columbus will be attached to the ISS at the end of 2007. These antennas are being developed in Poland by students and professors at the Institute of Telecommunications and Acoustics, Wroclaw University of Technology. Planned onboard equipment includes a digital amateur radio

television system for video uplink and downlink.

The ARISS team is also working to install externally-mounted amateur radio equipment on the ISS. This hardware will enable the crew to communicate with Earth-bound radio amateurs and school students using handheld systems that can be moved throughout the ISS. It will also support communications experimentation that will enable students and radio amateurs to receive telemetry data from ISS.

School Contact Process

Individual schools submit an application to the ARISS program to hold a ten minute interview with a crew member on the International Space Station (ISS). An ARISS internationally based school committee reviews and prioritizes all applications for incorporation into the flight queue. The school group committee then forwards all completed applications with their priorities to the ARISS international operations team. This team assigns an operations mentor to each school. The schools have several months to prepare for their contacts. The operations team recruits volunteer amateur radio operators that are cognizant in amateur radio satellite operations and are near the school to support the local school group contact. A school may have its own radio club or station, but it is not required. The local amateur radio volunteers support the school with the technical know-how to make the ARISS contact successful. They also provide the required antennas, radios, computers and software to establish an effective ground station at the school.

The classroom teacher needs on the order of six months to plan and prepare the school for the 10-minute amateur radio interview. Actually, the contact is just the pinnacle of a substantial educational program that centers around amateur radio in space. Grades K-12 are encouraged to participate. However, other educational institutions, including colleges and museums, may also participate.

Contacts are available year round, but depend on the work schedule of the crews on the ISS. The operations team attempts to schedule one to two contacts per week. During weeks involving extravehicular activity (EVA) or visiting Soyuz or Shuttle crews, the ISS crew is usually not available for school contacts.

The operations mentor works closely with the local amateur radio volunteers and the school teacher to ensure they are prepared for the contact. This includes the preparation of the questions to be asked. Since the operations mentor has performed numerous ARISS contacts, the mentor knows many tips to maximize the success of the contact. One important decision that is made early on is whether the contact will be made through a radio station that is installed at the school (a direct contact) or through a remote ground station (a telebridge contact).

Approximately 4-6 weeks prior to the ARISS event, several contact opportunities are generated by the operations team. This information is shared with the school group to arrive at a prioritization of contact times. These priorities, as well as specific information about the school and the questions to be asked by the students is forwarded to the ISS mission control team. These contact opportunities usually fall within a specific week for that particular school. Approximately one week prior to the event, the ISS mission control team provides the rise and set time for the event and the crew member that will participate in the event.

During contact day, the operations mentor and the school team are in constant

communication, sharing and confirming orbital data, synchronizing timing, sharing information on contact success and compiling metrics from the contact.

Once the contact is complete, the school is asked to fill out a NASA educational survey form. This helps NASA compile its own metrics on the educational benefit of this and other programs.

Worldwide Telebridge Facilities

The telebridge system is used when direct ISS communications is impractical, either due to visibility or timing constraints, (e.g. low elevation passes at school location, late night passes), national rules on unlicensed persons using an amateur radio, or technical concerns at the school. The telebridge system consists of an international network of ISS ground station volunteers that can be linked to school groups using a telephone conferencing system. See figures 1 and 2. This system is similar to NASA's system of tracking stations which were used extensively during the 1960's, 1970's and early 1980's to track human space flights. One school is interactively linked to the bridge with one ground station for the entire 10 minute pass. However, several school groups can be interactively connected to the bridge with several ground stations providing a direct link to the ISS for periods of up to 20 minutes. The school groups usually talk to the astronauts through a local radio system which is patched to the telebridge. If this is not practical, a speaker phone can be used; however this is not encouraged since it is not in the spirit of an amateur radio activity.

SuitSat-1

SuitSat-1, an amateur radio satellite, proposed by the Russian delegation to send greetings to school children in commemoration of the 175th anniversary of the Bauman Moscow State Technical University, was designed, developed and fabricated by the ARISS team. The hardware components for this system were launched and delivered to the ISS in September, 2005. The Expedition 12 crew assembled the satellite using a Russian Orlan spacesuit, already on board the ISS to house the amateur radio system. Schools worldwide submitted artwork to be flown on the satellite. Over three hundred items were compiled and two copies of the artwork CD were delivered to the ISS. One was inserted into the spacesuit prior to its deployment, and the other was made available for viewing by the ISS crew. An ARISS Slow Scan TV image was included on-board and was transmitted to Earth, providing additional opportunities for school children to participate in this exciting project.

The suit was deployed during an EVA on February 3, 2006. SuitSat-1 sent greetings and special words in several languages which school children could decode. Those who heard SuitSat and provided the special words and messages or recorded image telemetry were eligible to receive a certificate acknowledging their accomplishment.

A SuitSat website was designed to allow those participating in this project to enter their data and track the satellite. The site received over 9.5 million hits! SuitSat-1 received extensive media coverage from around the world: the NASA Education portal, Reader's Digest, Popular Science, NPR (All Things Considered), Japan CQ, CNN, MSNBC, AstroNet (Poland), CBS, Discovery Channel, Aljazeera, to name a few,

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A "Chicken Little" contest was held for participants to guess when SuitSat would reenter Earth's atmosphere. On September 7, 2006 at 16:00 UTC, SuitSat-1 re-entered the earth's atmosphere approximately 1400 km south-southwest of Western Australia. The

winners of the three categories (K-8, 9-12, and adult) will receive certificates.

Program Evaluation and Outcomes

Teachers evaluate the ARISS program after their contact with the ISS by submitting a NASA Education Evaluation Information System (NEEIS) form. Additionally, input obtained from crew debriefs is taken into consideration for program improvement. Awards in excellence given to ARISS members are also an indicator of the program quality. Students and teachers continuing their education in fields related to the ARISS program, schools which set up radio stations or continue on with related technologies, and remarks made by those involved with the program can provide necessary feedback to improve and refine the program. The items listed below are indicators of this program's success.

- Stephanie Radcliff experienced an ARISS contact as a student at Daviess County High School (DCHS) in Owensboro, Kentucky in May 2001. Today she is a graduate of Embry-Riddle University, and holds a degree in the aerospace field. She has applied and hopes to be accepted for astronaut training. Harold Wilson, the coordinating teacher of the DCHS - ARISS contact, remarked that it was the ARISS contact which inspired Stephanie to pursue this career.

- "Students were tracking the space craft, controlling the directional antenna, operating the radio transmitter and talking to an astronaut. Science doesn't come into the classroom better than this." - Matt Ryan, coordinating teacher of the Brigidine College contact in Sydney, New South Wales, Australia.

- Rita Wright, KC9CDL, was the first teacher to experience an ARISS contact at her school in Burbank, Illinois in December 2000. She has since retired and this year joined the ARISS team. She has formed a network with other teachers and is currently working on ARISS lesson plans.

- We are also working with the Schenectady Amateur Radio Association and our after-school program to begin a ham radio club for students. Thanks for making this [contact] possible for us. – Rita Moore, Central Park Middle School, NES, Schenectady, New York

- The radio equipment setup for the Mt. Carmel High School, San Diego, CA contact remained at the school to be used as the school's Amateur Radio station.

- Sonoran Sky Elementary, KA7SKY, received a Satellite Communicators Club award from AMSAT-NA. The school experienced a contact with the Expedition 8 crew, and continues with its amateur radio activities, including participation in Kid's Day and JOTA.

- Student SAREX volunteer, Mike Sufana, received his Aerospace Engineering degree and is now working at Northrop Grumman.

- SAREX student, Melissa Mladnic, from Jerling Jr. High, is attending Purdue University School of Aerospace Engineering with aspirations of becoming an astronaut.

- Boulder Hill Elementary School in Montgomery, Illinois has started an Amateur Radio club thanks to parent and ham volunteers. The students are learning about amateur radio, electronics and

communication basics. The school is on the waiting list for an ARISS contact.

- An Amateur Radio operator, from the Silver Springs Radio Club, demonstrated satellite communications to two classes of fifth grade students at Romeo Elementary School in Dunnellon, Florida. Using the AMSAT Oscar (AO-51) satellite repeater, the ham received calls from many stations. This demonstration was part of the preparation for an upcoming ARISS contact at the school. Another demonstration had been given at the school the previous year. The Silver Springs Radio Club will assist in the upcoming contact.

- A student who participated in a SAREX contact with astronaut Ken Cameron in 1994 is now an Air Force Academy graduate. She dreams of becoming an astronaut and attributes much of her interest in flying to her participation in that contact years ago. As a little girl, she was able to ask her question, "How does a fish swim in space?" Today she is a pilot and she continues her flight training on fighter jets.

- "The most valuable aspect [of the contact] was to help my students make a personal connection to the space program and to consider that a career in space aeronautics is a viable option for them. It humanized the space program and made it come alive as opposed to my students just thinking of it as something that is performed by scientists in white lab coats." – Jan French, teacher, Cincinnati Country Day School, Cincinnati, Ohio

- "We focused on the biology of living in space. The most valuable aspect, to me, was the interest in space exploration that was generated from the contact. Not only did it give us the opportunity to focus on biological issues associated with space travel, but it also exposed students to some of the physics associated with working in space and with communicating in space. One of my students even came up after the contact and asked me to add AP Physics to her course schedule for next year! We also discussed some basic issues about how the radio contact was made and about the radio equipment that was used." – Sarah Longino, Biology teacher, Timber Creek High School, Orlando, Florida

- E. L. DeGolyer Elementary School in Dallas, is an ARRL Big Project school, and as such, an Amateur Radio station was added to the school, sponsored by the ARRL. Students who participated in the DeGolyer - ARISS contact had earned their Amateur Radio licenses. This school's fifth grade students also participated in AMSAT's 2002 Annual Meeting held in Fort Worth where they took part in building S-band antennas for the AO-40 satellite (from cardboard boxes and aluminum foil). The Dallas Independent School District Video Production Crew produced a documentary of this event which included the Space Day activities that preceded it.

- "I witnessed a historic event at Bowie High School this morning when students communicated with Commander Bill McArthur on the International Space Station. Participating in activities such as this enhances our knowledge, not only of the direct application of the mathematics and science we learn in school, but of ways that our global community operates for the good of all mankind." - Kathy Kurtz, Regional Assistant Superintendent, Bowie High School, Bowie, Maryland

- In a ceremony held at Johnson Space Center, the Amateur Radio on the International Space Station team was presented with a JSC Group Achievement Award for the support provided during the Expedition 12 mission, which resulted in a record number of ARISS contacts performed.

- Bill McArthur, KC5ACR, presented ISS Ham Project Engineer Kenneth Ransom, N5VHO, with a Silver Snoopy award for his hard work and dedication to the ARISS program during Expedition 12. The pin flew on McArthur's first mission, STS-58, Columbia, in 1993.

Future ARISS Projects

In March 2006, Amateur Radio operators from AMSAT Germany tracked and received data from Voyager 1 using the 20m antenna at Bochum at a distance of 14.7 billion km. Its data was checked and verified against data from the Deep Space Network station. This was good news for the Amateur Radio community as NASA is currently pursuing an exploration of space, "to the Moon, Mars, and Beyond."

ARISS is considering educational payloads that may be included on these missions. A repeater on the moon, a remote amateur television, and a Mars telecommunications satellite are such possible payloads. These payloads will generate interest among students, encouraging participation in amateur radio projects and in space, science and technology fields. Through these projects and the extensive ham radio volunteer network, future generations of students will be inspired to pursue careers in math science and communications technology.

Appendix F

Maps

Map, ARISS-USA Radio Contacts, FY2007

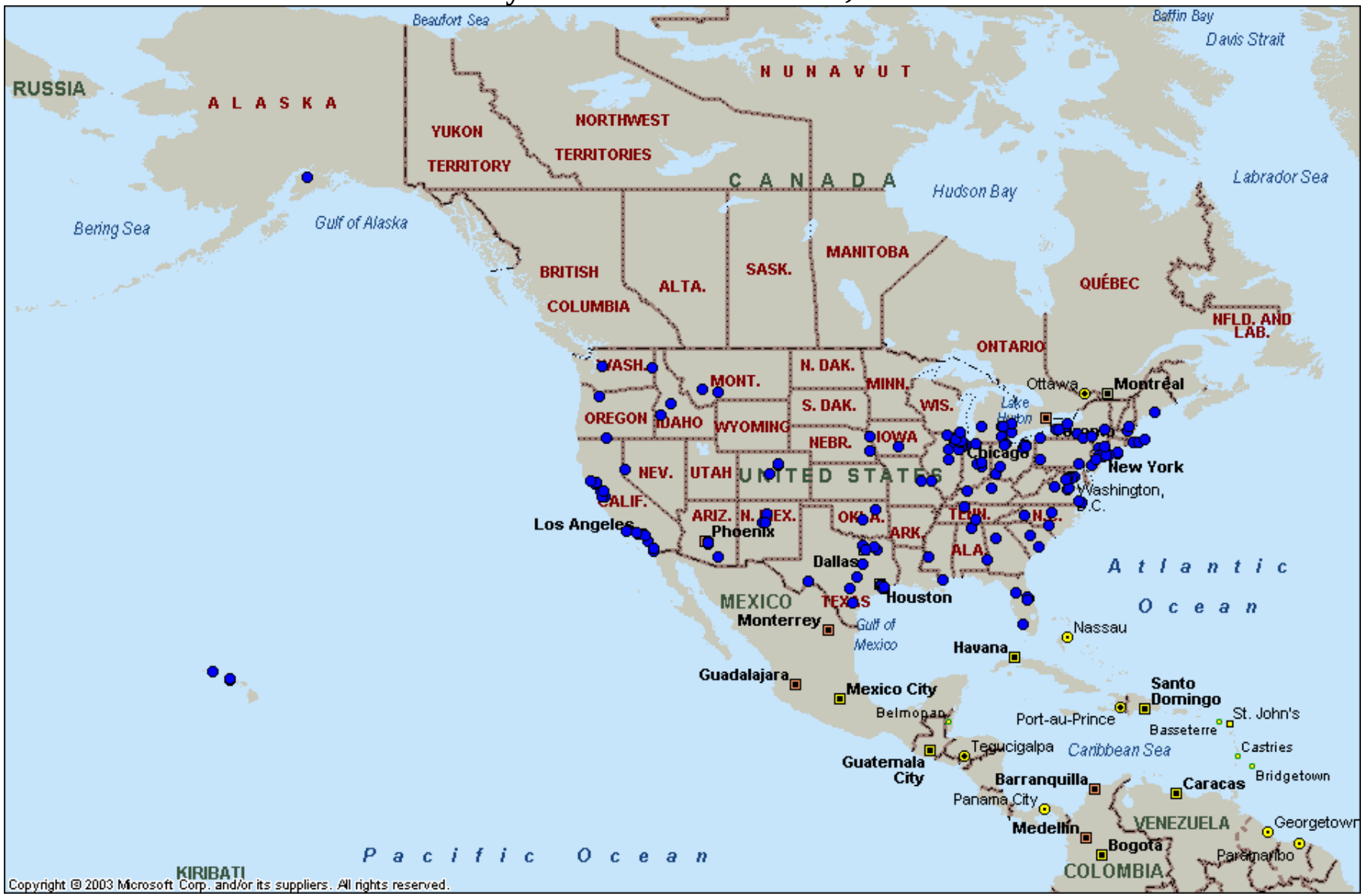
Map, ARISS-USA Radio Contacts through FY2007

Map, ARISS-International Radio Contacts through FY2007

ARISS USA-only School Radio Contacts, FY2007

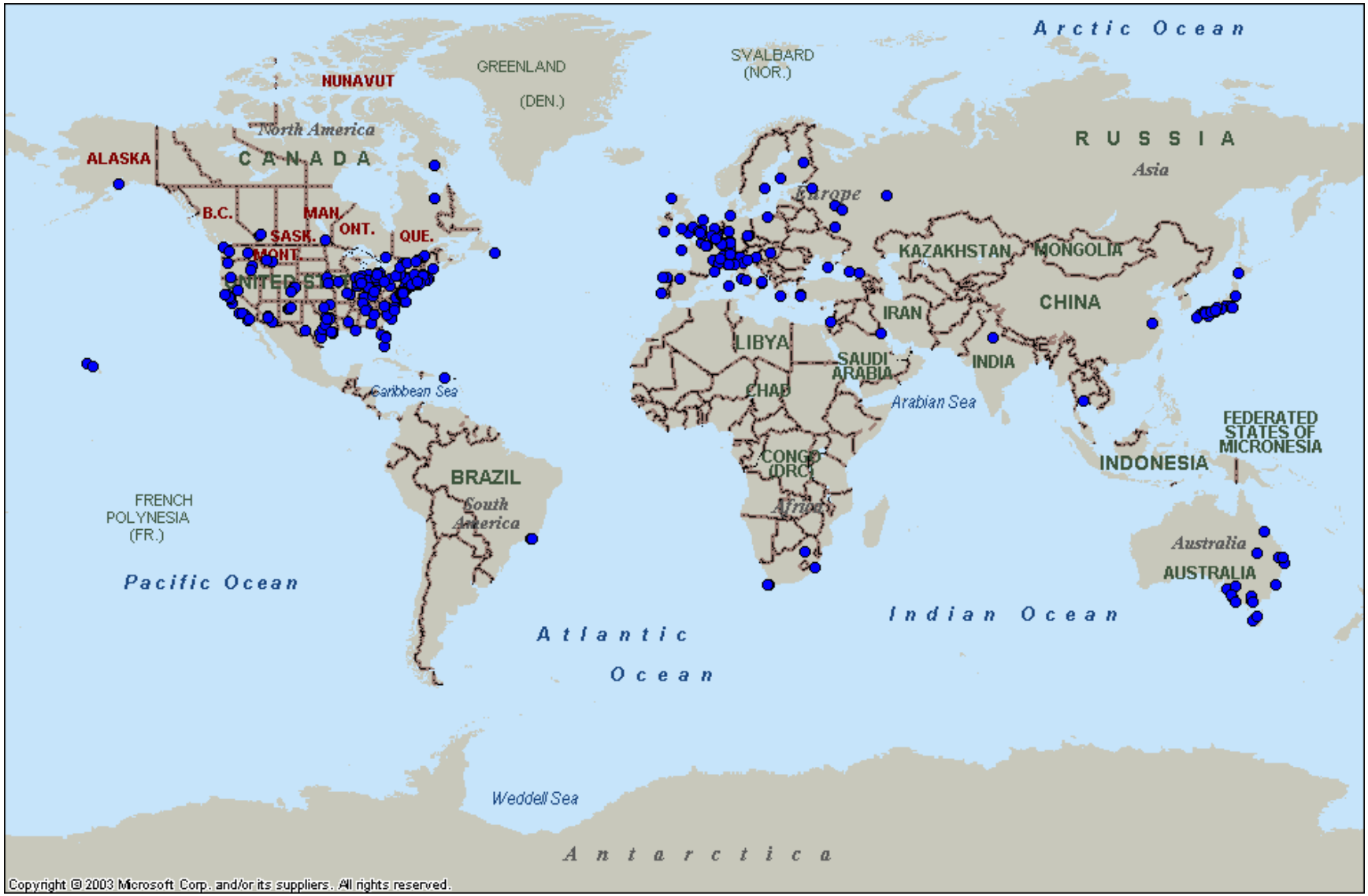
Notes: 1) ARISS assisted 34 U.S. schools and 33 other schools worldwide with radio contacts during FY2007.
2) Students at numerous other schools from around the USA and the world benefited from listening to radio contacts via Webcasts/audio streaming.
3) ISS crewmembers performed general outreach Amateur Radio contacts with children and adults from around the world.

ARISS USA-only School Radio Contacts, FY2001-2007



Notes: 1) ARISS assisted 165 U.S. schools and 156 other schools worldwide with radio contacts through FY2007.
2) Students at numerous other schools from around the USA and the world benefited from listening to radio contacts via Webcasts/audio streaming.
3) ISS crewmembers performed general outreach Amateur Radio contacts with children and adults from around the world.

ARISS-International School Radio Contacts FY2001 – 2007



Notes: 1) A total of 321 ARISS school contacts were made through FY2007.
2) Students at numerous other schools from around the world benefited from listening to radio contacts via Web casts/audio streaming.
3) ISS crew members performed general outreach Amateur Radio contacts with children and adults from around the world.