AMATEUR RADIO on the ISS

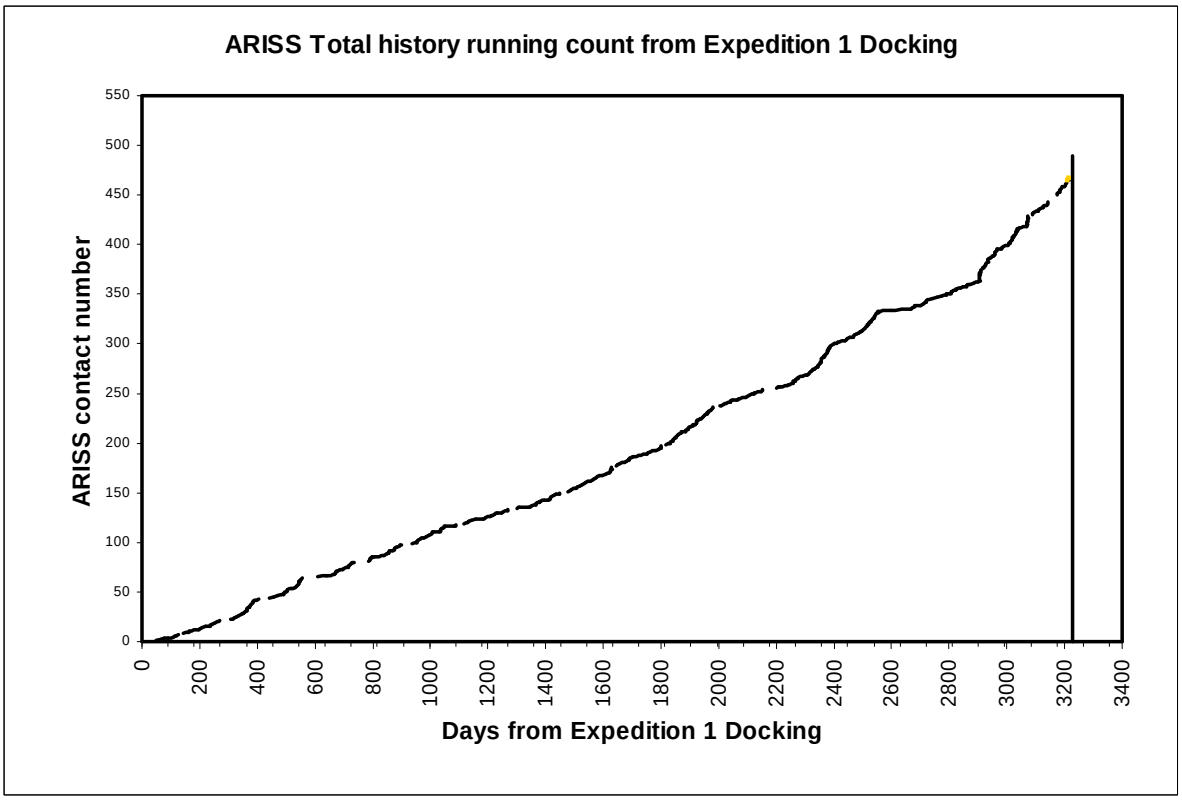
By

Keith Pugh, W5IU

Purpose and Objectives of ARISS –

The primary purpose of Amateur Radio on the ISS (ARISS) is to promote education of our youth in math, the sciences, engineering, and technology through exposure to the International Space Station (ISS) Program. A secondary purpose is to expose students and others to the world of Amateur Radio and the many benefits of this fascinating avocation.

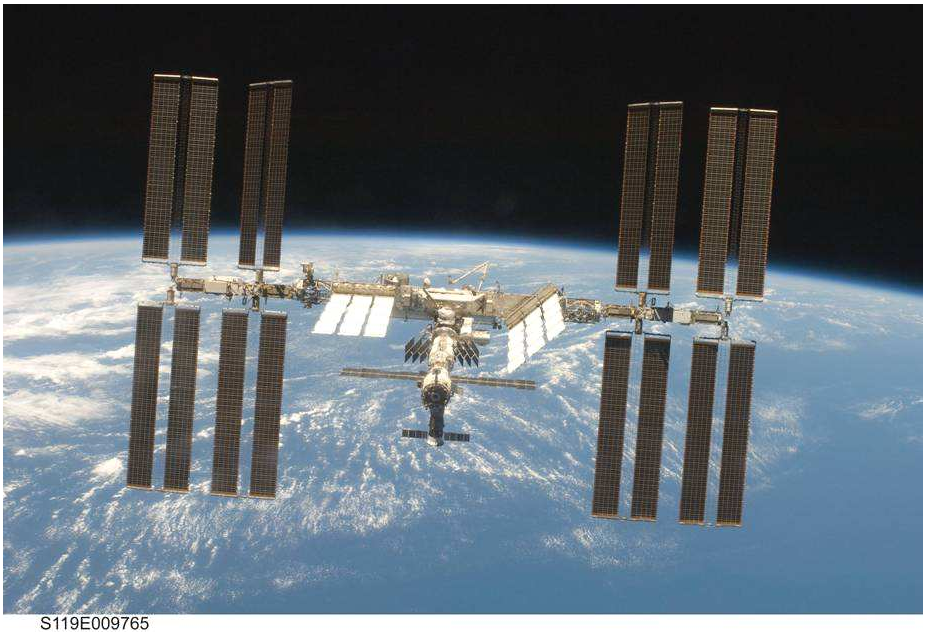
Working with professional educators worldwide and with the Space Agencies of the world, ARISS provides opportunities for students of all ages to talk and exchange ideas with Astronauts on board the International Space Station (ISS) while in orbit. Amateur Radio provides the media for this exchange to occur and the volunteers that facilitate the primary purpose.



470 Contacts at Report Time

A Proud Legacy – Historical Background –

ISS NOW COMPLETE – Starting 6 Person Crew Operations



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AMSAT's 40th Anniversary

ARISS leans heavily on Amateur Radio Satellite Technology and spirit. The first Amateur Radio Satellite, OSCAR-1, was launched on 12 December 1961, just over four years after Sputnik-1 on 4 October 1957. The Project OSCAR Group in California built and coordinated this launch. By 1969 the needs of the Amateur Radio Satellite community had out grown this operation and a group of devoted satellite people in the Washington, D.C., area formed the Radio Amateur Satellite Corporation or AMSAT. The year 2009 marks the fortieth anniversary of the formation of AMSAT.

Twenty Fifth Anniversary of Amateur Radio Human Spaceflight

In 1983, Owen Garroitt, W5LFL, flew on the Space Shuttle Columbia during mission STS-9 and carried Amateur Radio Equipment with him. He made many contacts on this mission including King Hussein of Jordan, JY1. I was one of the eager participants in this operation and planned to make a contact as well. One of the local television stations covered the attempt from my Ham Shack. Only the "Big Guns" within the US (Moonbounce class stations) were successful. We learned first hand about the FM "Capture Effect" on this mission but everyone had fun anyway. This was the start of twenty five years of successful manned spaceflight operations on board the Space Shuttle, MIR, and ISS.

Just 25 years later, Owen's son Richard Garriott, W5KWQ, flew on the ISS to celebrate this occasion. His ten days in space created a memorable event in late October 2008. He made several hundred voice QSOs, a number of school contacts, several special event contacts, and sent down a number of SSTV pictures.

Richard's flight started the 25th Anniversary celebration that was celebrated throughout the end of 2008 and into January 2009. Special modes and operations were exercised on the ISS to commemorate this event and the reaction was very positive.

If you made any kind of contact with the ISS during this event, details of how to apply for special certificates can be found at http://www.ariss.org.

Ten Years of Operation on the ISS

The first elements of the ISS were launched in 1998 and eleven years later it is nearly complete. During this time nearly 500 school contacts have been made between students and the astronauts. The 400th contact occurred in January 2009. In addition to the school contacts, several of the astronauts have taken a special interest in making many Hams happy with a space contact and contacts have been made on all continents, all states, and over 130 DXCC countries. The

ISS has also been used as a Digipeater, a Cross Band Voice Repeater, a launch platform for other satellites (PCSAT, SuitSat, etc), and will be used even more in the future. In 2009, the crew has been increased from three to a full compliment of six. The additional crew members have a definite impact on Amateur Radio Operation. This presents a challenge to the scheduling of operations. I'll talk more about that later.

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ARISS Organization –

Based on the legacy of Human Spaceflight dating back to 1983 and Owen Garriott's STS-9 flight, including the Shuttle Amateur Radio Experiment (SAREX), and MIR, ARISS was formed in 1996. Founders were Roy Neal (SK), K6DUE; Frank Bauer, KA3HDO; Rosalie White, K1STO; and Matt Bordelon, KC5BTL. The team is governed by a group of ARISS International Working Group delegates from Canada, Europe, Japan, Russia, and the USA. Delegates are chosen from the Radio Amateur Satellite Corporations (AMSATs) of the world, the National Amateur Radio Organizations (such as ARRL), and the Space Agencies of the world. These delegates meet via monthly telephone conferences, and about once a year in face-to-face meetings (last year in Moscow, this year in the Netherlands). In between, activities are coordinated by e-mail and additional telephone conferences as necessary. These delegates set the policy (with advice from the space agencies) for operation, coordinate equipment for the ISS, coordinate with education organizations, coordinate school selection for contacts, and provide oversight to the ARISS Operations Team – the other major ARISS group.

With the resignation of Frank Bauer, KA3HDO, this year for personal reasons, ARISS has had to pick a new delegate for AMSAT-NA and elect a new ARISS International President. Will Marchant, KC6ROL, stepped into the AMSAT-US slot, and Gaston Bertels, ON4WF, is the new ARISS-I President. In a separate action, Maurice-Andre Vigneault, VE3VIG, became the ARISS-Ca Delegate representing AMSAT-Canada.

ARISS Operations Team

The ARISS Operations Team is made up of ARISS Mentors, scheduling/technical representatives, and an orbital prediction specialist. An ARISS Operations Lead is selected from within the ranks on a periodic basis. This group meets weekly by telephone conference and much more frequently via e-mail and telephone. ARISS Mentors are the volunteers that work with the schools, teachers, and local Amateur Radio groups that actually make the contacts with the ISS. Scheduling/technical representatives work within the space agencies, primarily NASA in the USA and the Russian Space Agency to secure the final schedules for the contacts. These scheduling representatives also coordinate training of the Astronauts in the use of the equipment on board the ISS and procedures for its use. The orbital prediction specialist does the long

and short term predictions necessary to support the scheduling of all of the contacts. I will talk more about these functions and their relationships with each other in subsequent paragraphs outlining the scheduling and performance of the contacts.

School Contacts this Year –

School Contacts over the last year have been numerous and varied. We have been blessed with some very enthusiastic astronauts. Mike Fincke, KE5AIT, alone made a record 50 School Contacts. Sandy Magnus, KE5FYE; Koichi Wakata, KC5ZTA; Michael Barratt, KD5MIJ; Frank DeWinne, ON1DWN; and Robert Thirsk, VA3CSA, have each made numerous contacts. These astronauts represent several nationalities and contacts in their home countries and native languages have been very popular. Mike Fincke has family ties with India so several of his Crew Pick contacts were with Indian Schools. Mike also speaks several languages. Koichi Wakata has been popular in Japan, Frank DeWinne has been popular throughout Europe, and Robert Thirsk has made many Canadian contacts. Actually, contacts within the US have been in the minority this year. The previous record for school contacts in a year (2007 with 75 contacts) will be broken by a large margin by years end (2009 is currently at 72 at the end of August).

Mike's India

& USA

JAPAN, CHINA,

Student participation at the schools has ranged from Kindergarten to University. During the summer months and at vacation times, a number of contacts have been made with Summer Camps, Scout Groups, Astronomy Groups, Museums, etc. As usual, the student reactions to the contacts are the reward for all of the effort expended by Teachers, Ham Radio Volunteers, and ARISS Volunteers.

Local students reach out to outer space

NASA program links up Fassett with International Space Station

By JULIE M. McKINNON
BLADE STAFF WRITER

Talk about long distance: Fassett Middle School students peppered an International Space Station astronaut with questions yesterday as he orbited about 220 miles above North America — at 17,500 miles an hour.

Using ham radio airwaves, 16 students at the Oregon school had nearly 10 minutes to pose questions to Michael Fincke, commander of the station's Expedition 18, as part of a NASA educational program. The Pennsylvania native, who is a colonel in the U.S. Air Force, is on his second space station trip.

"Our planet is definitely incredible," Colonel Fincke told Fassett's about 550 students. "I wish all of you could see what I'm seeing right now."

The Toledo Mobile Radio Association supplied ham radio equipment that provided the connection between Colonel Fincke and Fassett. The exchange was part of a program called Amateur Radio on the International Space

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THE BLADE/AMY E. VOIGT

A map indicates the relative positions of the International Space Station and Fassett Middle School during the linkup.

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ARISS Operations –

The wheels start rolling for a school contact with the submission of an ARISS Application for an ISS contact. The latest application form is available at: http://www.ariss.org Ideally, a teacher hears about the possibility of a contact through professional societies, from other teachers, from Amateur Radio Operators within the community, or by many other routes. The teacher, with the help of local Amateur Radio Operators, fills out the multiple-part application and submits it to the regional ARISS organization. The regional organization reviews the application, obtains clarification if necessary, ensures the application is forwarded to the ARISS international education committee, and enters it into the list of applicants in the order in which it was received. A separate list is maintained for each region of the world and candidates are picked from each region in proportion to the number of applicants in the list. Another list is maintained for "Crew Pick" contacts. These contacts are with schools that are picked by the Astronauts for their own reasons and are usually separate from the main list. Astronauts are allocated "Crew Pick" contacts based on their interest in the program and willingness to support contacts from the main list. The main list can be quite long and the waiting period can be correspondingly lengthy. Currently, the wait for US applicants is about one year. Every effort is made to keep the wait to a minimum, but contacts are generally limited to somewhere between one and four a week period depending upon the crew's willingness to support contacts and the workload on the ISS

Another factor to consider is whether the contact is to be "direct" or via "telebridge." For a "direct" contact, a ground station is set up at the school and the contact proceeds directly through that station with the station on-board the ISS. For a "telebridge" contact, the ground station is located remotely (possibly half way around the world) from the school and the ground station is connected to the school and other elements through a telephone conference bridge. ARISS OPS has developed and maintains a list of acceptable telebridge stations around the world (these are currently in the mainland US, Hawaii, Australia, Argentina, Belgium, and South Africa).

The school expresses a preference for the type of contact in their application and ARISS Ops will honor this preference whenever possible. A "telebridge" contact requires much less equipment at the school and is much more flexible on timing of the contact than a "direct" contact; however, it actually requires more coordination on the part of ARISS Ops to carry out. A list of requirements for each contact follows:

1. The ground station must be within the footprint of the ISS during the time of the contact and the ISS should have a peak elevation at the ground station of more than about 15 degrees. Higher passes are more desirable

to maximize the contact time and minimize effects of local obstructions on the contact.
2. The pass selected must occur during normal school hours as stated on the application or within an acceptable alternate time.
3. The pass time selected must be within the crew's normal off duty but awake time. Exceptions must be approved by the Space Agency Medical Personnel. Crew sleep periods are normally fixed, but can be "sleep shifted" during special work periods that coincide with Space Shuttle or other activities.

Picking and approving passes that satisfy the above requirements involve several steps that are outlined below:

1. A list of possible contacts is selected from the prioritized list of contacts maintained by ARISS over a period of time (usually for an ISS Expedition).
2. ARISS Mentors are assigned to each school as soon as possible. The ARISS Mentor establishes contact with the school and local ham volunteers, and verifies the content of the application (many times things have changed at the school since the original application was prepared).
3. The list of candidates is broken up into "direct" vs. "telebridge" contacts.
4. Direct candidates are submitted to the orbital prediction specialist for processing into the "best weeks" list. "Best weeks" are long term predictions that will permit selection of schools that have passes within a certain time frame that satisfy all of the nominal contact requirements above. A school may have several different "best weeks" within the overall time frame.
5. Selections are made based on contact priority and "best weeks" for each school and the ARISS Mentors obtain preferences for the available weeks from each school.
6. The ARISS Mentor continues the dialog with the school to firm up the requirements for the station, answer questions from the teacher and the local Amateur Radio Operators, assist the teacher with resources for lesson plans and in solicitation of questions and names from the students, and obtain a short description of the school and its activities for forwarding to the Astronauts. The ARISS Mentor also prepares the school for filling out a post contact survey for ARISS and NASA.
7. At about four or five weeks before the week selected for a school, detailed pass predictions for the contact are requested from the orbital prediction specialist. These predictions are verified by the ARISS Ops Lead and sent to the ARISS Mentor for forwarding to the school for prioritization within their own school schedule. The passes are ranked #1 through #n by the school and the local Amateur Radio Operators and sent back to ARISS Ops.
8. At this point, the pass ranking, student names, questions, and school description are passed on to the NASA planners by the ARISS scheduling representative for final determination of the selected pass. Usually this

final pass time is available one to two weeks before the contact. In the case of Russian contacts, a similar process is performed with the Russian Space Agency.

9. Before the contact time, a final uplink message is sent to the Astronaut containing the time, station callsigns, frequency information, the school description, and the student's questions, along with their first names, in the order the questions are expected to be asked.
10. At this point, the contact is ready to go from a planning standpoint.

For telebridge contacts this process is modified somewhat. Telebridge contacts are usually fitted into the schedule between the "best weeks" for direct contacts or are scheduled during special times that are specified by the school or event and agreed to by ARISS Ops. Telebridge contacts are usually reserved for schools that either cannot obtain local ham club support for a direct contact or have time requirements that are not flexible. The modified steps for a telebridge contact follow:

1. Telebridge contacts are prioritized by the same process as direct contacts, but they are usually done when direct contacts are not possible.
2. For telebridge contacts, the orbital prediction specialist prepares a list of the passes for each telebridge station that can support a contact during the dates/time frames requested by the school and within crew constraints. This list can contain many passes and can include multiple stations.
3. The ARISS Lead pares down the list when possible and sends the remaining passes to all of the telebridge stations that have passes on the list for verification of support.
4. The ARISS Lead receives the responses from the telebridge stations and prepares a list of available passes for further prioritization by the school. This list is sent to the ARISS Mentor and he forwards this list on to the school.
5. Once the prioritized list is returned by the school, the process continues in much the same manner as for a direct contact.
6. One other step is added – a Contact Moderator is selected by the ARISS Lead to oversee final readiness verification at the school and at the telebridge station. The Moderator also makes sure school personnel and any audience is aware of how the contact will be done and the Amateur Radio involvement in the contact. A Moderator is added since many times the level of expertise at the school during the contact is less than it would be during a direct contact.
7. At the appropriate time, the Moderator turns control over to the telebridge station to establish contact with the ISS.
8. Control is then maintained by the telebridge station operator and the school contact supervisor until the pass is over.
9. The Moderator then completes the process with a closing statement.

In recent years, ARISS has succeeded in including distribution of the audio from the contact over the internet by utilizing EchoLink and IRLP. These are two methods of including many more listeners worldwide in the distribution. Doing this with a telebridge contact is relatively easy. With a direct contact it is a little more difficult, but recently success has been achieved by feeding the audio into a PC at the school and utilizing Skype (an internet telephone) to forward the resulting information to the operator that completes the conversion to EchoLink or IRLP. These operations are also carried out by ARISS volunteers.

The last thing that happens in an ARISS Contact is the enthusiastic response of the school kids, and their increased interest in science and ham radio when the contact is successfully completed. This is the pay the volunteers cherish for their efforts and is the reason we eagerly volunteer for this duty.

Plans for the Future –

SuitSat-2 now ARISSat-1

Since the deployment of SuitSat-1 and the "stir" it created, ARISS has been working on SuitSat-2. This year has been very productive in this effort and the hardware/software will be ready for shipment to Russia by years end. Launch should occur in the spring of 2010. One major change has occurred: the Russian Orlan Space Suit that was to house the remainder of the satellite has been discarded early to make more space available on the ISS. ARISS was able to retain up-mass allocation for the equipment and a reservation for launch during an EVA, but we had to "shift gears" and come up with a new housing for the equipment. This task is well underway and will not impact the schedule. Due to this change, the satellite has been re-named ARISSat-1. It will continue to be called RadioSkaf in Russia and on the documentation. Details of ARISSat-1 are spelled out in other papers.

Columbus Module

The European Space Agency (ESA) Columbus Module was installed on the ISS last year along with the Amateur Radio Microwave Antennas (L and S Band) developed for it. Work continues defining the nature of equipment being developed for eventual use within the Columbus Module. Meanwhile, a dual band (VHF/UHF) antenna will be shipped to the ISS for use on the Columbus Module. First usage of this new antenna will be with the Ericsson Hand Helds (Phase 1 Hardware) that are currently on station to support expanded Amateur Radio Activity from the Columbus Module.

ARISS Project Committee

ARISS maintains a Project Committee to receive, process, and prioritize new proposals for ARISS Projects. Currently, this committee is working on plans for

the L and S band equipment for the Columbus Module and for support of the current Phase 1 and Phase 2 hardware. This includes providing power supplies and cables to support radio operation in multiple locations on the ISS and eliminating the dependence upon batteries for the VC-H1 SSTV unit. If you have suggestions for projects, please document them and submit them for action.

Summary –

ARISS is alive and well. Now that the ISS is fully populated with a six person crew, expect more activity than ever before. Support this expanded activity by getting out the word to the world and volunteering your time and experience in support of all of the activity. Help bring forth new generations of people with an expanded knowledge of science, space, and technology.

SSTV Video

From W5DID

From VK5ZAI

From G0SFJ