THIS IS SUITSAT-1, AMATEUR RADIO STATION RS0RS!!

Frank H. Bauer; KA3HDO
Amateur Radio on the International Space Station (ARISS) International Chairman
AMSAT Vice President for Human Spaceflight Programs
NASA Goddard Space Flight Center

Introduction

"**This is SUITSAT-1, Amateur Radio Station RS0RS**!!"

These words will echo from space in the near future, inspiring students, exciting ham radio operators and touching the world.

If all goes as planned, a unique Extra-Vehicular Activity (EVA)—or Spacewalk will be conducted on the International Space Station (ISS) in early February 2006. During this spacewalk, the ISS crew will push a Russian spacesuit overboard---with no humans in it, of course! But this Spacesuit holds the hopes, dreams and creativity of students around the world. And for a week or two, this Suit-robot-satellite will take on a life of its own---parroting students voices from around the world, voicing down suit health telemetry and sending a special commemorative picture to all who want to receive it.

Suitsat-1 (also called Radioskaf or Radio Sputnik in Russian) mission activities will be conducted on the amateur radio (ham radio) frequencies, a bit above the FM broadcast band. The voice signals can be picked up with ham radio receivers and FM VHF (Very High Frequency) scanners—like police-band scanners.

Students, scouts, teachers, ham radio operators, and the general public are encouraged to track the space suit, hear the conversations from space, copy the suit telemetry and capture the picture. A special certificate will be distributed to those who receive the voice signals and those who capture the picture. We also will have a special award for those students who receive the "special words" that are embedded in the messages from our SuitSat student "crew members." These special words are in different languages---English, French, German, Spanish, Russian, and Japanese. So you are encouraged to record the SuitSat downlink audio and get help from fellow students who know these languages.

Also included in this spacesuit is a computer Compact Disk (CD) with images of over 300 items collected from schools and educational organizations around the world. These include creative works of art from students as well as student signatures, school or scout logos, and class or group pictures. Students, schools and educational organizations that participated in the development of this disk earlier this year will all be part of the SuitSat spacewalk---as their creative works, signatures and pictures all float in space!

The following will provide more details on the Suitsat-1 mission and provide you information on how you and your school can participate.

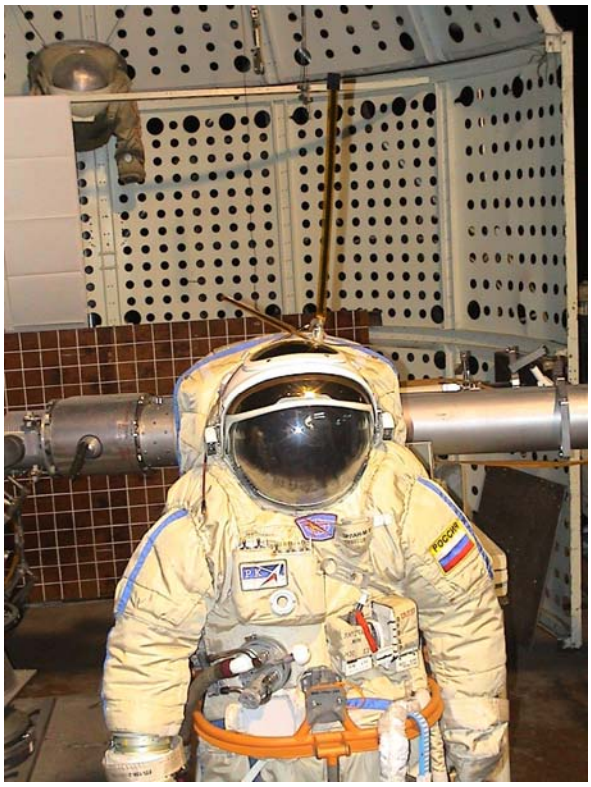
The Suit and On-Board Equipment

Through the miracle of ham radio, the ingenuity of the international space agencies, the help of students and schools, and the tireless work of a few volunteer "rocket scientists" Suitsat-1 was born.

SuitSat is sponsored by ARISS (Amateur Radio on the International Space Station), an international working group consisting of volunteers from national amateur radio societies (the American Radio Relay League in the U.S.) and the internationally-based Radio Amateur Satellite Corporation (AMSAT).

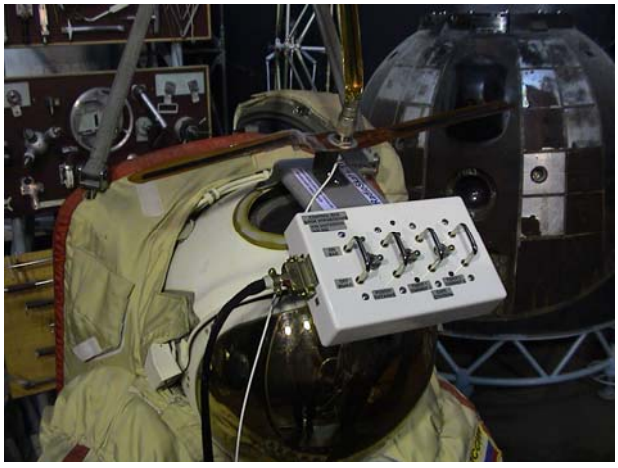
The idea for SuitSat was first conceived by the ARISS-Russia team, led by Sergey Samburov, RV3DR, and was extensively discussed at the joint AMSAT Symposium/ARISS International Partner meeting in October 2004. The project, is being led by project manager A. P. Alexandrov and Deputy Project Manager A. Poleshuk from RSC Energia, located in Korolev (Moscow area) Russia. The project was developed primarily by a joint US/Russian team. On the US side, the hardware project development was led by AMSAT member Lou McFadin, W5DID.

Embedded in the Russian Orlon Space Suit (Figure 1) are two boxes housing the ham radio transmitter and the micro-controller and electronics that stores and plays back the digital voice and video recordings. Also inside the spacesuit will be some batteries to power the system and the "School Spacewalk" CD. On the outside of the spacesuit is the SuitSat antenna and the crew interface control box---the crew interface device that turns the SuitSat power on. See figures 2 to 3. Prior to the spacewalk, the ISS crew connects cables to the two internal boxes (the Kenwood transmitter box and the micro-controller electronics box), figure 4, and stores these two boxes in a fabric container that is housed inside the space suit (see figure 6). Next, they mount the antenna and the interface control box to the exterior of the suit helmet as shown in figure 2. Next, the batteries, interface control box and antennas are all connected to the



Russian Orlon Spacesuit
Figure 1

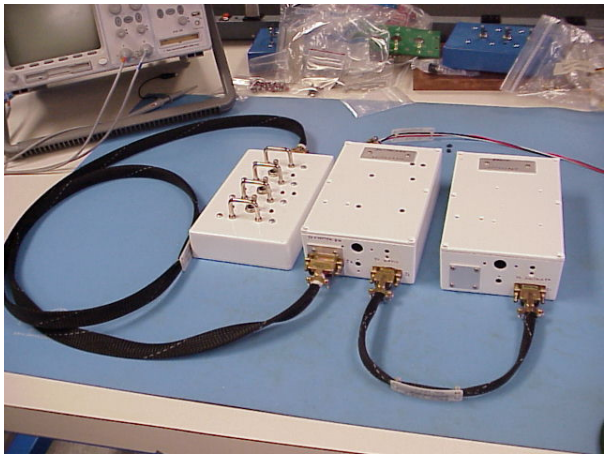
Crew Interface Control Box
Figure 3



SuitSat Antenna & Crew Interface Control Box
Figure 2

two internal boxes with special connecting cables. The SuitSat is then ready for deployment. Once the crew is outside on their EVA, they turn all three switches on the control box to the ON position and deploy the spacesuit from ISS. Their objective is to put Suitsat in a retrograde orbit so it "de-orbits" relative to ISS. This orbit will appear from the ground to be

ahead of the ISS, while it is actually slowing down and is below ISS.



SuitSat Interface Control Box, Transmitter Box and Digitalker/Micro Controller Box
Figure 4

About eight minutes after the crew flips the three switches, the Kenwood transmitter, figure 5, will power up. About eight minutes after that, the first voice telemetry message will be transmitted and SuitSat operations begin! (This 16 minute delay is a crew safety measure).

Kenwood TH-K2 Transmitter
Figure 5

Please remember that this mission is battery operated. In other words, when the batteries run down, SuitSat stops transmission. We also do not know how fast SuitSat will heat up. So our ability to predict mission life is not very good. Our prediction is 1-2 weeks. However, it may stay on for as little as little as an hour or as long as several weeks. So if you want to hear SuitSat, your objective is to get prepared for SuitSat operations ahead of time.

Suitsat-1 Transmission Specifics

Suitsat Hardware (Transmitter and Digitalker/Microcontroller Box inside Fabric Container)
Figure 6

All transmissions will be on 145.990 MHz FM. This is in the VHF (2 meter) portion of the amateur radio band. It can easily be picked up with a simple VHF hand-talkie ham radio, although ground-based antennas with higher gain are preferred to hear SuitSat for the entire 10 minute pass. SuitSat audio can also be received using a police band scanner. An external antenna is highly encouraged. SuitSat will be transmitting 0.5 watts into the same type of antenna currently used on the ISS ham radio station.

Additional Downlink Frequency and Information for Ham Radio Operators

Since SuitSat will be operating on the ISS world wide packet uplink frequency of 145.99 MHz, it is requested that all packet operations on that frequency be suspended for the duration of the SuitSat transmissions. Keeping transmissions off the downlink frequency will help to avoid local interference to the 1/2 watt downlink signal from SuitSat.

The ISS crossband repeater is under consideration for being temporarily reconfigured to listen for the SuitSat transmissions and then retransmit them on 437.80 MHz. It is hoped that persons with minimal equipment might have a better chance of hearing the SuitSat retransmissions from the crossband repeater since ISS has a power output of 10 watts. Please help us to avoid interference problems by not using the crossband repeater while SuitSat is active because anything else the repeater hears on 145.99 MHz will interfere with the SuitSat retransmissions.

Tracking Suitsat-1

If you plan to hear Suitsat, you need to know when it will be visible in your area. To do this, you need to obtain some orbit prediction software or see the ISS orbital path from the internet. Information on this can be found at the following:
http://www.amsat.org
http://www.amsat.org/amsat-new/tools/
http://science.nasa.gov/Realtime/jtrack/

Please understand that when you use an orbital prediction program you need an accurate synchronization of time (to a few seconds).

Downlink Specifics

To fully understand the Suitsat-1 downlinks, some background information is in order.

One of the reasons our Russian colleagues were interested in developing SuitSat was as an on-orbit commemoration of the 175th anniversary of the Bauman Moscow State Technical University. This university is where many of the engineers in the Russian Space Agency graduated. As a result, the Russian-generated messages include congratulatory comments to the Bauman Moscow State Technical University.

In addition to the messages from Russia, there are voice messages from students in Japan, Europe (Spanish and German), Canada (French) and the USA (English). The USA message is from a student enrolled in the Eastern Middle School, Silver Spring, Maryland. Eastern Middle School is a NASA Explorer School. In addition, the Suitsat-1 ID was voiced by a Korean-born young lady enrolled in Paint Branch High School, Burtonsville, Maryland, USA. As you can see, Suitsat-1 truly has an international flavor!

Special Word

Several of the student messages include a special word. One student project for SuitSat will be to copy all the special words (in different languages) and submit them to the ARISS team for special educational award recognition.

Suit Telemetry

The suit telemetry is sensed by the SuitSat microcontroller and converted to a voice message. Three telemetry data messages will be transmitted. These will be periodically repeated.

Specifically, the suit telemetry will be transmitted in the following order:

-Mission Time
-Suit Temperature
-Battery Voltage, where 28 Volts is the nominal voltage

The SuitSat team is quite interested all three pieces of telemetry as it will be a predictor for SuitSat mission life.

SuitSat Downlink Picture

The downlink picture will be transmitted using a set of audio tones, similar to a computer modem, using a ham radio picture standard called Slow-Scan Television (SSTV). SSTV, developed many years ago, provides Cell Phone quality pictures. A single picture was installed in the SuitSat microprocessor memory and will be downlinked. SuitSat uses an SSTV data transmission standard called Robot 36. This standard sends the entire image in 36 seconds.

For more information on SSTV, you may check out:
http://www.marexmg.org/spacecam/spacecam.html
http://www.ultimatecharger.com/SSTV.html

Suitsat-1 Downlink Sequence

Now that you understand the specifics, what can you expect when SuitSat is over your area? To save SuitSat power and to maximize the time that SuitSat is operational, 30 second pauses have been included between each of the voice messages. So the sequence will be as follows:

-SuitSat Voice ID (5 seconds)
-International voice message, Suit Voice Telemetry, or SSTV Image (15-45 seconds)
-30 second pause
….and repeat

The international message order will be as follows:

-Voice Telemetry
-Russian Message
-Europe Student Messages (Spanish and German)
-Bauman Institute Message (Russian)
-Canada Student Message (French)
-Mr. Alexandrov Message (English)
-Japan Student Message (Japanese)
-USA Student Message (English)
-SSTV Picture

Copying SuitSat Data

If you are planning on copying the Suitsat-1 downlink, you are highly encouraged to record it so you can replay it later. Tape recorders or digital voice recorders with at least 10-15 minutes of continuous recording are recommended. You can then use these to submit Suit telemetry information, the special words and the SSTV image to the ARISS team and the space agencies.

"School Spacewalk" CD

As part of the SuitSat project, a CD with hundreds of school pictures, artwork, poems, and student signatures is included. Two identical CDs were flown, one will go in the suit as part of the Suitsat-1 spacewalk. The other is available for the crew to review. There are approximately 300 items on the CD including artwork, school and educational organization logos, student signatures and student and school pictures. A composite of several of the items installed on the CD are shown in figure 7. As you can see, these are from all over the world (Japan/Asia, Europe, Russia, Canada, US, South America and Africa). Several NASA Explorer Schools participated as well as numerous ESA and Russian Space Agency-sponsored schools.

SuitSat postings of telemetry, special messages and the SSTV Image

This is still a work in progress. Please return to the web site often to get details on this as the SuitSat mission gets closer.

Special Certificates

Those that hear SuitSat will be eligible to receive a special certificate in commemoration of your achievement. Also, if you receive the SSTV image, copy the telemetry and/or copy the special words, special certificate endorsements will be provided. To receive a SuitSat special certificate, please use the standard QSL card address in your area of the world. These are located at: http://www.rac.ca/ariss/oindex.htm#QSL's Indicate the time and date you heard SuitSat and any other information that will acknowledge your reception of the information (telemetry, SSTV picture, etc) that will confirm that you should receive the proper endorsements on your certificate. Please include a self addressed stamped envelope. And provide a big envelope and protective cardboard if you do not want your certificate folded or damaged during shipment.

Current Status

On May 10, 2005 NASA gave the OK to fly. Four short weeks later, the USA built SuitSat hardware was sent to Russia for final testing, certification and integration with the Russian-built hardware.

On Thursday September 8 at 13:08 UTC, Progress 19P lifted off from the Baikonur Cosmodrome in Kazakhstan. Included in the 2.5 tons of fuel, food and supplies was the Suitsat amateur radio hardware. The successful docking of Progress to ISS on September 10 culminated the successful design, development, certification and delivery of this exciting educational project. The ISS Expedition 11 crew has unpacked the SuitSat equipment, making it available for installation, use and deployment by the Expedition 12 crew. SuitSat deployment is currently scheduled for February 2, 2006.

Conclusions

Figure 7

The SuitSat project was an extremely challenging endeavor for the ARISS hardware team, primarily due to the very short development time. Throughout the development effort, we have involved students. As SuitSat nears deployment, we are looking forward to the continued involvement and participation of students worldwide.

For all the amateur radio operators in the world, this is your chance to get your local school involved. Bring a radio, orbit tracking program, SSTV equipment, an audio recorder and your enthusiasm into the school. SuitSat promises to capture the imagination of the students and, if successful, will allow the students to learn more about space, amateur radio and satellite orbits. Please volunteer and wish our robotic astronaut in the Russian Orlon suit a good and successful journey in space!!

Additional Information

ARISS web site: http://www.rac.ca/ariss
AMSAT web site: http://www.amsat.org
http://en.wikipedia.org/wiki/Orlan_space_suits
http://www.issfanclub.com
http://space.cweb.nl/article.html?id=407 photo of how cosmonauts get into the Orlan suit

Acknowledgements

On behalf of the ARISS International team, the author would like to acknowledge and congratulate the Suitsat hardware development team for their "Can Do" spirit and ability to deliver the Suitsat hardware on such a very challenging schedule.

Specifically, we would like to thank the following: Alexander Alexandrov, Alexander Poleshuk, Sergey Samburov, RV3DR, Lou McFadin, W5DID, Kenneth Ransom, N5VHO, Frank Bauer, KA3HDO, Mark Steiner, K3MS, Steve Bible, N7HPR, Joe Julicher, N9WXU, Rawin Rojvanit, Farrell Winder, W8ZCF, Jeffery Winder, KB8VCO, Hiroto Watarikawa, JJ1LYU, Stan Wood, WA4NFY, Herb Sullivan, K6QXB, Dave Taylor, W8AAS, Deanna Lutz, K7DID, Claire Fredlund, Carol Jackson, KB3LKI, Kenwood and Microchip Technology Inc.

The author would also like to acknowledge the tremendous support, teamwork and volunteer spirit of the ARISS-International team as well as the technical, financial and administrative support of the ARISS member organizations--the AMSAT organizations and IARU organizations (ARRL in the USA). Also special recognition is in order to the space agencies: NASA, Energia, ESA, JAXA & CSA. Together we are pioneering the new frontiers of amateur radio and educational outreach.