Human Spaceflight, ARISS & Future SuitSat Missions

Amsat Symposium
Oct 27, 2007

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Building & Operating Spacecraft Means Paying Attention to the Details

Amateur Radio on the International Space Station (ARISS)

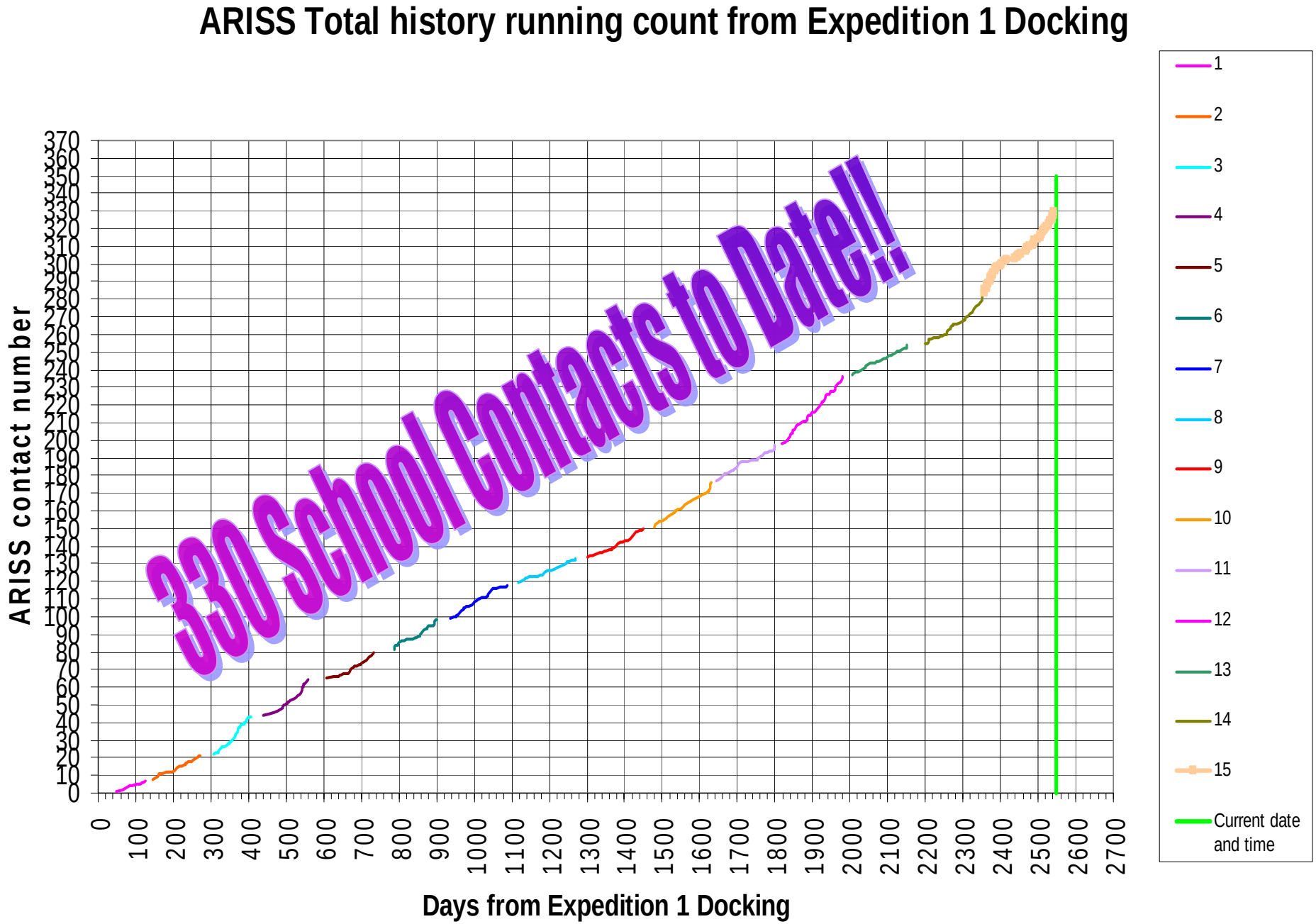
What is ARISS?

- International program that inspires students, worldwide, to pursue careers in science, engineering and mathematics through communication with the ISS on-orbit crew via amateur radio
- Local community drawn into this once-in-a-lifetime human spaceflight pursuit
- Provides an experiment platform for new telecommunications techniques
- Promotes interest in the amateur radio (ham radio) hobby as a link to better engage students in science and math

ARISS development, operations and student mentoring is performed almost exclusively by a world-wide network of amateur radio volunteers who are passionately committed to the above objectives

ARISS Capabilities & Impact

- FGB-mounted 2 m Ericsson radio for voice & packet
  - Operational less than 2 weeks after first crew arrival making **ARISS the first payload on ISS**
- Developed 4 multi-band antenna systems; mounted on the periphery of the Russian service module via 3 EVAs→**2 m, 70 cm, L band, S Band, HF and GPS**
- Developed and installed 2 L/S-band antennas on European Columbus Module
- Installed UHF/VHF Kenwood D-700E in Service Module, near the dinner table and window
- Successful completion of over **330** international schools—kudos to the operations team and volunteer mentors on a job well done!
- **16 consecutive ISS expedition crews** used our radio system to conduct thousands of QSOs with hams on the ground since November 2000
- Over **15,000** students touched each year
- **Millions, worldwide** have heard an ARISS connection
- Millions, worldwide see ARISS contact on ISS IMAX film
- Witnessing students, worldwide, become scientists and engineers as a direct result of the ARISS connection
- The first Spacesuit satellite—SuitSat-1/Radioskaf deployed from ISS; SuitSat-2 on the horizon.


ARISS Total history running count from Expedition 1 Docking
330 School Contacts to Date!!!
ARISS contact number
Days from Expedition 1 Docking
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
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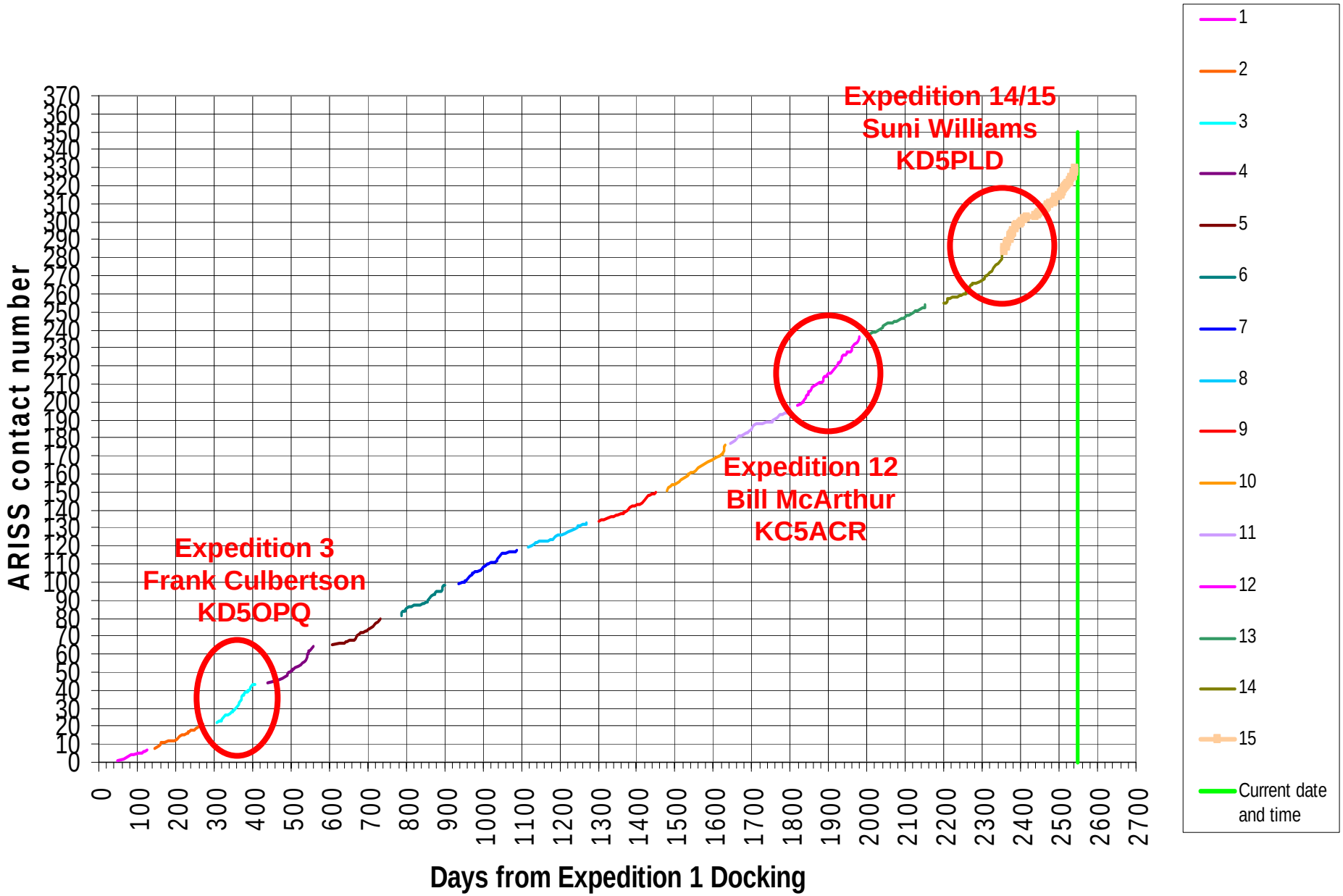
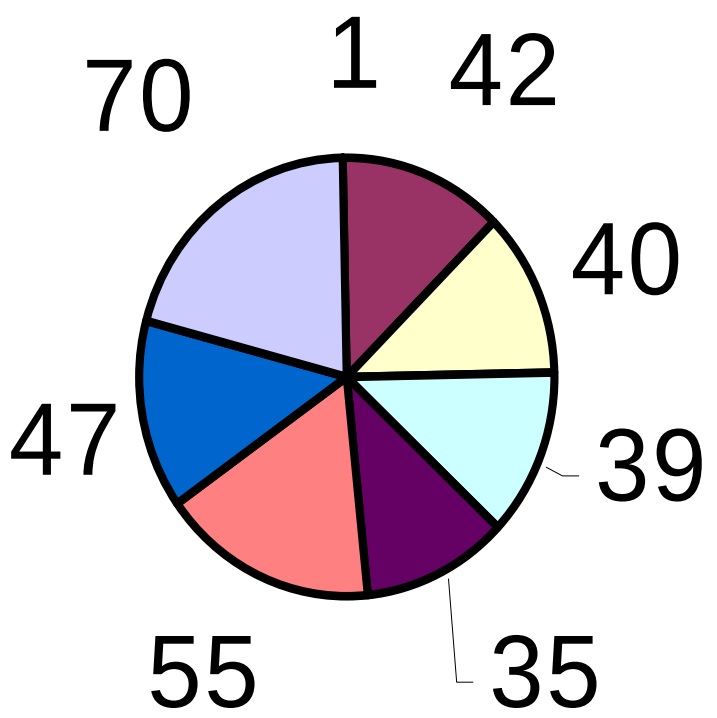
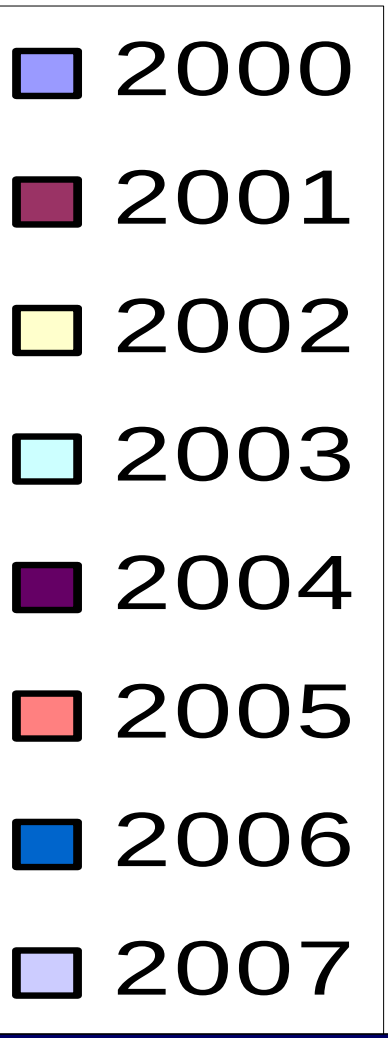
14
15
Current date and time

ARISS Total history running count from Expedition 1 Docking



School Contacts Per Year





Crew School Contact Statistics

Top 5 expedition school contacts:
1) Exp 15—39
2) Exp 12—38
3) Exp 14—25
4) Exp 10—23
5) Exp 3—22

Top 5 individual school contact counts for a single tour:
1) Bill McArthur – 37—Exp 12
2) Suni Williams – 33—Exp 14/15
3) Leroy Chiao – 23—Exp 10
4) Frank Culbertson – 22—Exp 3
5) Clay Anderson – 21—Exp 15/16

Suni Williams
KD5PLD

2006-2007
Space Flight Participants

Anousheh
Ansari

Sheikh
Muszaphar
Shukor

Charles Simonyi

Sputnik 50th Anniversary

ARISS Contact
Air & Space Museum
Sept 29, 2007

Crew Ops Observations & Expectations

- Past few crews have been very prolific in performing school contacts (Bill McArthur, KC5ACR, Suni Williams, KD5PLD, Clay Anderson, KD5PLA)
- General QSOs sporadic; dependent upon crew interest
- High crew workload over next 6 months will result in little and at times no school or general QSO contacts on Expedition 16
  - Install and c/o US Harmony Node→ starting now
  - Install and c/o European Columbus Module→Next Shuttle flight
  - Install and c/o Japanese Kibo Module→follow-on Shuttle flight
  - 3 Shuttle flights
  - 2 Soyuz flights
  - Inaugural ATV (Europe Automated Transfer Vehicle) flight
- Packet ops will continue on 145.825 simplex
- Mid-2009 change to crew of 6 will significantly change ops dynamics
  - Many more schools and general QSOs??

	LAUNCH DATE	CDR	FE-1	FE-2
Exp. 15 Shuttle up	June 2007 (13A.1)*			Clay Anderson **KD5PLA**
Exp. 16 Soyuz up	October 2007*	Peggy Whitson **KC5ZTD**	Yuri Malenchenko **RK3DUP**	
Exp. 16 Shuttle crew	Oct 2007 (10A)*			Dan Tani **KD5DXE**

Current Crew Complement (Not including Shuttle Crew)

*** Indicates planning date as of May 2007. Subject to change**

	LAUNCH DATE	CDR	FE-1	FE-2
Exp. 14/15 Shuttle up	December 2007			Suni Williams **KD5PLD**
Exp. 15 Soyuz up	April 2007	Fyodor Yurchikhin **RN3FI**	Oleg Kotov	
Exp. 15 Shuttle up	June 2007 (13A.1)*			Clay Anderson **KD5PLA**
Exp. 16 Soyuz up	October 2007*	Peggy Whitson **KC5ZTD**	Yuri Malenchenko **RK3DUP**	**No Schools**
Exp. 16 Shuttle crew	Oct 2007 (10A)*			Dan Tani **KD5DXE**
Exp. 16 Shuttle crew	Dec 2007 (1E)*	**School Contacts Resume**		Leopold Eyharts **KE5FNO**
Exp. 16 Shuttle crew	Feb 2008 (1J/A)*			Garrett Reisman **KE5HAE**
Exp. 17 Soyuz up	March 2008*	Sergei Volkov	Oleg Kononenko **RN3DX**	
Exp. 17 Shuttle crew	July 2008 (15A)*			Sandy Magnus **KE5FYE**
Exp. 17 Shuttle crew	Oct 2008 (ULF2)*			Koichi Wakata **KC5ZTA**
Exp. 18 Soyuz up	October 2008*	Michael Fincke **KE5AIT**	Alexander Kaleri **U8MIR**	
Exp. 18 Shuttle crew	Jan 2009 (2J/A)*			Greg Chamitoff **KD5PKZ**

*** Indicates planning date as of May 2007. Subject to change**

ARISS Update—Team, Hardware Status, Future Opportunities

2007 Delegate Changes

Stepping Down

Ken Pulfer, VE3PU
Canada

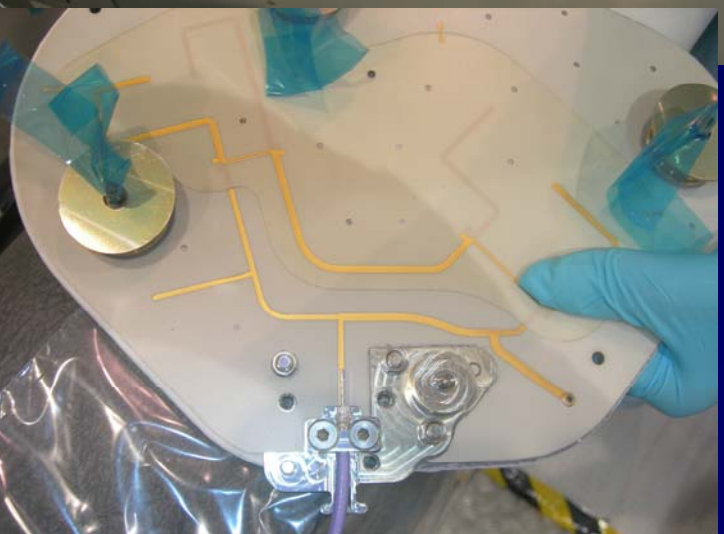
Robin Haighton, VE3FRH
Canada

Stepping Up

Daniel Lamoureux, VE2KA
Canada

Stefan Wagener, VE4NSA
Canada

Two L/S Band Antennas Installed on European Columbus Module!!



Installation & C/O Completed Week of October 20, 2007

Hardware Development/Ops Lessons Learned

- ISS is not like Mir→don't expect the same type of ops

  Differences:
  - Mir crew relied on ham radio equipment to support family contacts, radiograms, air to ground comm
  - Ham radio on Mir was the prime external outlet for the crew
  - ISS communications system much more robust
  - IP Phone on ISS requires very few ARISS family contacts

  Similarities:
  - Proven educational outreach capability that requires nearly zero setup overhead
  - "Dyed in the wool" hams use the equipment extensively

- After 7 years of continuous operations little crew time for hardware installation, checkout or troubleshooting

Lesson Learned

Future ARISS hardware needs to be Satellite-like (i.e. completely autonomous and commandable)

ARISS Phase 3 Hardware Concept

1996 ARISS Phase 3 Concept

- Use SuitSat-2 core hardware to support multi-band autonomous ops
  - Voice
  - Packet
  - SSTV
  - Student Experiments

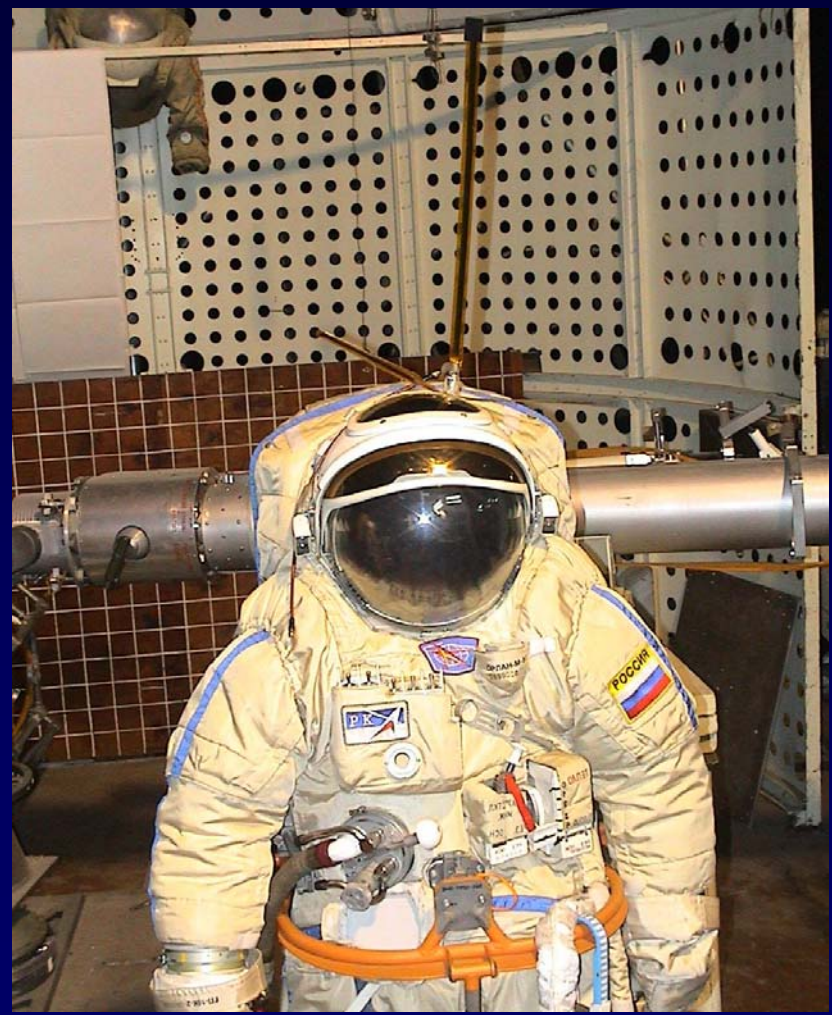
SuitSat-2 Core Hardware

Current/Future Telebridge Stations

Proposed Augmentation of Bridge Stations (South America and High Latitude)

SuitSat-1--Amateur Radio Extra Vehicular Activity (EVA) In a Space Suit

- 2-week battery-operated satellite station
- Capabilities:
  - International Student Message Downlink
  - SSTV Picture
  - Telemetry
  - School Spacewalk—DVD with school name, artwork and student names included
- Deployment: Feb 3, 2006
- Re-entry: Sept 7, 2006



The Amateur Radio on the International Space Station (ARISS) Team

SuitSat-1/Radioskaf-1/AO-54

Certificate of Recognition

presented to

William C. McArthur
KC5ACR

Presented in recognition of your outstanding volunteer support to ensure the successful development, crew training, deployment, operations, educational outreach and information dissemination of the SuitSat-1 mission. As a result of your efforts, SuitsSat-1 captured the imagination of people and students worldwide providing unprecedented outreach and visibility for a ham radio event.





The Amateur Radio on the International Space Station (ARISS) Team

SuitSat-1/Radioskaf-1/AO-54

RS0RS, Commemorative Certificate

presented to

Frank H. Bauer
KA3HDO

For Successful Reception of the SuitSat-1 radio downlink during its operation from February 3, 2006–February 18, 2006.





The Amateur Radio on the International Space Station (ARISS) Team

is proud to present the

Chicken Little Prognostication Award

to

Aaron Russo

Student K-8

As one of the "Select Few" to successfully predict the reentry of the SuitSat-1/Radioskaf-1/AO-54 satellite.

SuitSat Deployment: February 3, 2006 @ 23:03 UTC
SuitSat-1 Reentry: September 7, 2006 @ 16:00 UTC

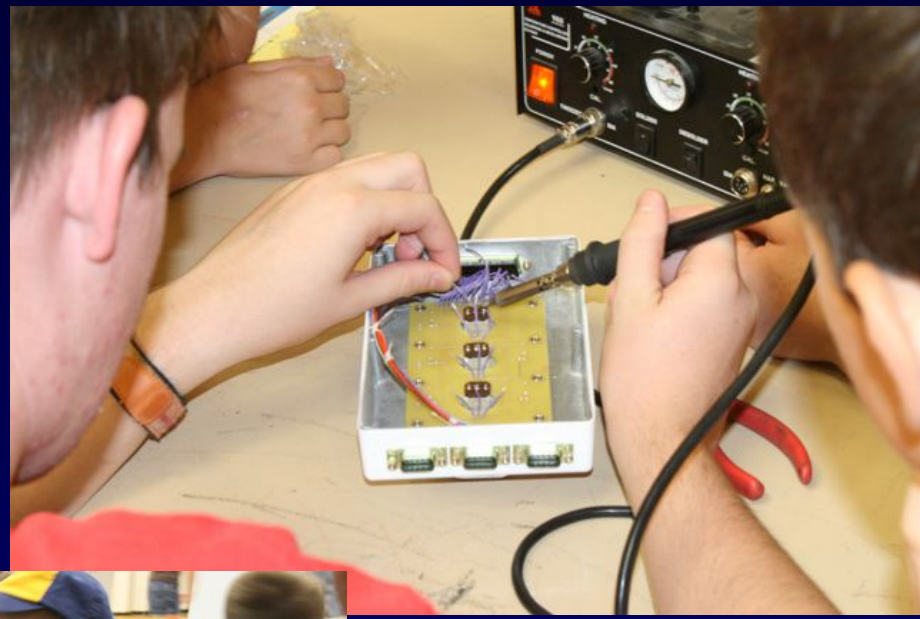
SuitSat-1 Chicken Little Contest Winners
Re-entry: September 7, 2006 at 16:00 GMT

K-8 Student	High School Student	Adult
Aaron Russo - 10 August	Kaleb - 17 August	Brian W4OGU - 07 September
Kai Thomas - 12 August	Jconnop - 17 August	N3RCU - 07 September
Matt - 17 August	Joanna K W. - 17 August	SW6JIV - 07 September
Ralf Klebermass - 17 August	leila - 24 August	Beth Ransom - 07 September
Alexander Akers - 06 September	alex - 31 August	Kazumasa Ibata - 07 September
Joshauah - 11 September	Stanislav Babenko - 05 Sept	Reidar Larsen - 08 September
andy bond - 11 September	weathernut27 - 07 September	Chad Briggs - 08 September
Abriana - 15 September	mike - 08 September	kb3nds - 08 September
lucy bullfrog - 24 September	Addison Call - 10 September	nalro - 08 September
cameron... - 04 October	Richard - 03 October	kg6hsq - 09 September

SuitSat Future

- Design work underway for SuitSat-2
- Expected shipment to Russia: June 2008
- Expanded educational outreach
  - DVD with student pictures
  - Student audio downlinks
  - Pre-developed lesson plans (3 levels)
  - College students supporting hardware/software development
- Hardware Design features:
  - Proven SuitSat-1 safety interlock
  - Software Defined Transponder (SDX) system (RF & DSP)
  - New transmitter, receiver & antenna system
  - Solar arrays from NASA SMEX-Lite project
  - Additional sensors
  - SSTV with up to 4 cameras for SSTV downlink
  - Up to 4 experiment ports

Maricopa, Arizona Scouts Participate in SuitSat-2 Development
September 13, 2007



The Future

- On January 14, 2004, US President Bush proclaimed a new exploration initiative for NASA---go to the Moon by 2020, Mars next and beyond Mars later
- ARISS team developing Exploration Initiative strategy
- ARISS's solid performance and outstanding international teamwork is recognized and respected by the Space Agencies
- The challenges will be high due to the long path lengths

ARISS Information

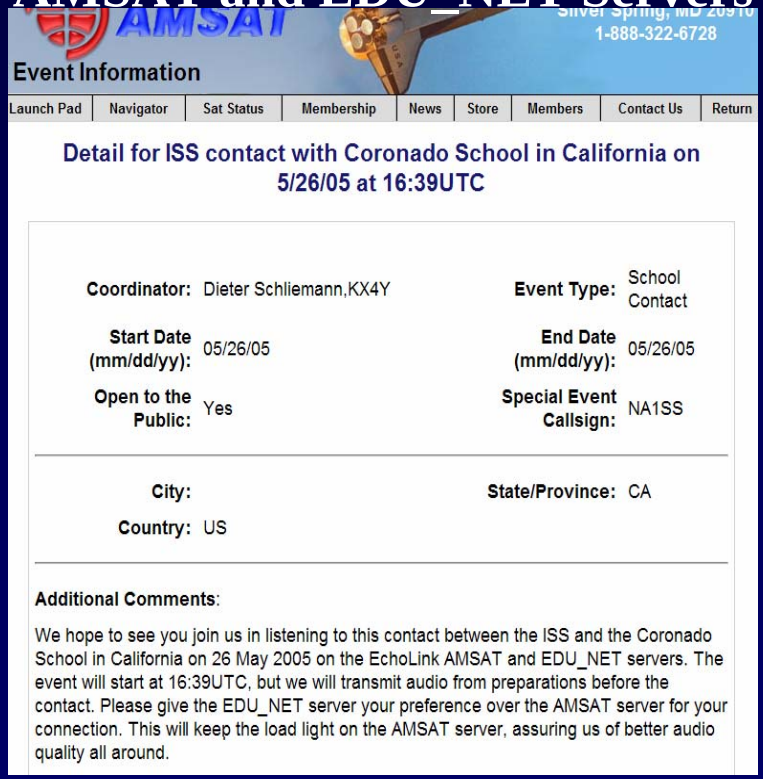
http://www.rac.ca/ariss

Backups

Voice Over Internet Protocol (VOIP)

IRLP, Echolink and Internet Streaming Provides a Wider Reach to Schools and Ham Radio Operators

Echolink
AMSAT and EDU_NET Servers



www.amsat.org
Calendar of Events

IRLP
9010 "Discovery" Reflector

www.discoveryreflector.ca

Columbus Module Antenna Installation and Inspection

Installation

Inspection