AMATEUR SATELLITE FREQUENCY COORDINATION REQUEST

(Make a separate request for each space station to be operated in the amateur-satellite service.)

Have you read the instructions? Here is the link

http://www.iaru.org/uploads/1/3/0/7/13073366/instructions_iaru_amateur_satellite_coordination_request.doc

Please do NOT submit the request before it is 100% filled and signed.

Administrative information:

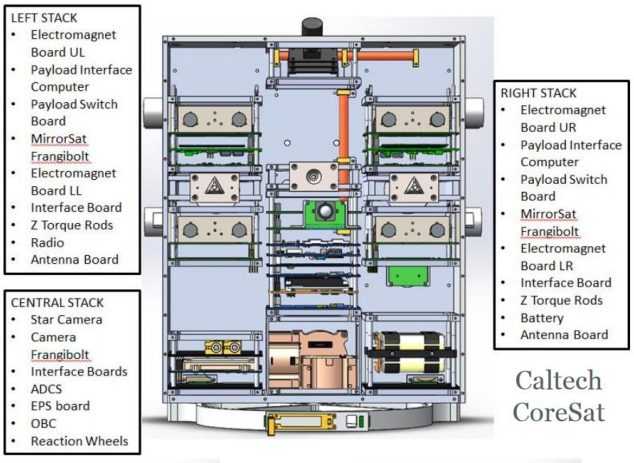
0	**DOCUMENT CONTROL**	
0a	Date submitted	
0b	Document revision number	1
1	**SPACECRAFT (published)**	
1a	Name	AAReST
1b	Notifying administration	
1c	API/A number	
2	**LICENSEE OF THE SPACE STATION (published) or responsible amateur in case of educational mission**	
2a	First (given) name	Raveendranath
2b	Last (family) name	Pullanhi
2c	Amateur Radio Call sign	VU2RVJ
2c1	licensed since	1994
2d	Postal address	Dept. of Aerospace Engineering, IIST, Valiamala(P.O.), Thiruvananthapuram, Kerala 695547
2e	Telephone number (including country code)	+91 9446303305
2f	E-mail address (licensee will be IARU's point of contact and receive all correspondence)	raveendranath@iist.ac.in
2g	Licensee's position in any organisation referenced in item 3a.	Adjunct Professor

3	**ORGANISATIONS (published) — complete this section for EACH participating organization**	
3a	Name of organization and/or educational institution	California Institute of Technology
3b	Postal address	1200 E California Blvd. Pasadena, CA 91125 USA
3c	Telephone number (including country code)	
3d	E-mail address	
3e	Web site URL	http://www.pellegrino.caltech.edu/aarest1/
3a	Name of organization and/or educational institution	Surrey Space Centre, Uni. Of Surrey
3b	Postal address	
3c	Telephone number (including country code)	
3d	E-mail address	
3e	Web site URL	http://www.surrey.ac.uk/ssc
3f	National Amateur Radio Society (including contact information)	AMSAT INDIA No. 201, 2nd Main Road, Mahalakshmi Layout, Bangalore 560086 India.
3g	Does your National Amateur Satellite organization and/or National Amateur Radio Society endorse this request?	National AMSAT Organisation Yes National Amateur Radio Society Yes
3h	Name and email address(es) of the person(s) you've contacted in the National AMSAT Organisation or National Amateur Radio Society	Name: Mr. Nitin Muttin, VU3TYG Secretary, AMSAT-India Phone: +91 9880018675 Email: vu3tyg@yahoo.co.in
3i	Will any person or organisation involved with the project be, directly or indirectly, financially compensated for operating the satellite and ground station(s)	No
3j	If you've answered yes in 3i, please explain.	N/A

Space station information:

4	**SPACE STATION (published)**	
4a	Type of mission Tick applicable box(es)	Amateur combined with Educational
4a3	If mission type in 4a is Amateur combined with other missions, will the transmitters or receivers operating in the amateur radio frequencies be used to control, or retrieve data (telemetry, payload, etc.) from, the non-amateur mission sub-systems?	N/A
4a4	If you've answered yes in 4a3, please explain.	N/A
4b	Mission(s): List and describe in clear text the project mission(s)	*A telemetry beacon will be provided during all modes of operation.* *A: Commissioning* The satellite must first perform key tasks for communications, power safety, and commanding of payloads via the on-board computer (OBC). After this, the attitude determination and control system will perform key maneuvers for power safety via B-dot and 3-axis pointing modes. *B: Educational Mission* The satellite is being built in collaboration between Caltech, Surrey, and IIST students as a technology demonstrator. *C: Outreach* The satellite aims to increase widening participation of satellite technologies for engineering and science within the US, UK, and India. Additionally, the satellite aims to take images of the Moon and stars and send back data from the international payloads. *D: Extended Mission* It is planned that the satellite will continue after 1 year with further IIST and Surrey payload experiments. Requested Frequency bands: Transmit in UHF (channel in 435-438 MHz

		band), Receive in VHF (channel in 144-146 MHz band)
4b1	Amateur Satellite Bands used:	144-146 MHz 435-438 MHz
4c	Planned duration of each part of the mission.	A: 1 month B: 6 months C: Full mission D: Mission duration: 1 year, but expected to continue operation for extended technology demonstration
4d	Proposed space station transmitting frequency plan.	
4d1	List all the frequencies (or frequency bands) requested and describe the function of each	A single 25 kHz channel in the 144 – 146 MHz band for amateur radio health beacons and payload data downlink.
4d2	Frequency tuning range (in MHz) of transmitter and tuning step increment (in Hz or kHz)	Unknown – full data sheet online: http://www.astrodev.com/public_html2/downloads/datasheet/HeliumUserManual.pdf
4d3	EIRP (in dBm)	30 dBm
4d4	List all ITU emission designator For each transmitter	BBBB 123 45 25kH F2D WN
4d5	Common description of the emission including modulation type AND data rate	FSK at 9600 bps
4d6	Type of antenna, antenna gain and pattern	½ Wave Monopole
4d7	Attitude stabilisation, if used	Yes
4d8	Service Area	
4e	Proposed space station receiving frequency plan. List for each frequency or frequency range:	
4e1	Requested frequency and function	A single 25 kHz channel in the 435 – 438 MHz band for amateur radio health beacons and payload data uplink.
4e2	Frequency tuning range (in MHz) of receiver and tuning step increment (in Hz or kHz)	Unknown – full data sheet online: http://www.astrodev.com/public_html2/downloads/datasheet/HeliumUserManual.pdf
4e3	ITU emission designator for each transmitter and emission type	BBBB 123 45 25kH F2D WN

4e4	Common description of the emission including modulation type AND data rate for each transmitter and emission type	FSK at 9600 bps
4e5	Noise temperature for each receiver onboard the satellite	Unknown – full data sheet online: http://www.astrodev.com/public_html2/downloads/datasheet/HeliumUserManual.pdf
4e6	Associated antenna gain and pattern for each receiver onboard the satellite	Omnidirectional monopoles with 3 dBi
4f	Physical structure, including dimension and mass:	Full and open documents of the mission progress available online: http://www.pellegrino.caltech.edu/aarest1/ Many academic papers published online.
4g	Functional Description of each satellite sub-system, including non-amateur payloads	 The Caltech CoreSat comprises a bespoke ~9U structure with bespoke solar panels, COTS EPS and Battery (P60 unit from GOMSpace), COTS ADCS Unit (3-axis unit from CubeSpace) with 3 magnetorquers, 3 reaction wheels, 2 magnetometers and a star tracker for precision pointing.
4h	Electrical Power budget. (average power consumption and power generation in Watts)	Preliminary worst-case budgets as shown

System	Sub-System	Voltage (V)	Power (W)	Current (A)	Resistive Load (Ω)
Docking	Top Left EMS	5	3.25	0.65	7.692307692
	Top Right EMS	5	3.25	0.65	7.692307692
	Top EMS Electronics	5	0.5	0.1	50
	Lwr Left EMS	5	3.25	0.65	7.692307692
	Lwr Right Ems	5	3.25	0.65	7.692307692
	Lwr EMS Electronics	5	0.5	0.1	50
LIDAR	Lidar	5	2.5	0.5	10
OBC	Power Switchboard	5	0.5	0.1	50
	Payload I/Face Computer	3.3	4.9995	1.515	2.178217822
	Payload ISL	5	0.5	0.1	50
Thruster Assembly	Thruster Ctrl	5	0.5	0.1	50
	Thruster Heater	7.4	0.999	0.135	54.81481481
	Thruster Px Transducer	12	0.1248	0.0104	1153.846154
	Plenum Valve	12	0.99996	0.08333	144.0057602
	Nozzle Valve	12	0.99996	0.08333	144.0057602
ADCS	CubeComputer	3.3	0.200013	0.06061	54.44646098
	CubeControl	3.3	0.249975	0.07575	43.56435644
	CubeTorquer - X	3.3	0.363	0.11	30
	CubeTorquer - Y	3.3	0.363	0.11	30
	CubeCoil	3.3	0.134442	0.04074	81.00147275
	CubeWheel - start up	7.4	0.72000002	0.097297	76.05555344
	CubeWheel - mean	7.4	0.269064	0.03636	203.520352
	CubeWheel Electronics	3.3	0.33	0.1	33

Encryption

4i	Will all transmissions (telemetry formats and equations, payload data, etc.) from the satellite have descriptions of modulations, protocols, formats, etc., published and publicly available on the project web site?	Yes, we will need amateur support to receive images from our novel space telescope. Surrey have an extensive history in fully publishing and aiding AMSAT missions – and will continue to do so.
4j	If you've answered no in 4i, please explain.	N/A
5	**TELECOMMAND (NOT published)**	
5a	Telecommand frequency plan.	
5a1	Proposed space station telecommand frequencies	A single 25 kHz channel in the 143 – 146 MHz band for amateur radio health beacons and payload data downlink is requested.
5a2	List all ITU emission designators for each transmitter	25kH F2D WN
5a3	Common description of the emission including modulation type AND data rate	FSK at 9600 bps
5a4	Radio Link budget(s)	

Uplink (VHF) @ 5 deg elevation			
Ground Station	Transmit power	10	W
	VHF antenna gain	14.5	dB
	Feed loss	4.1	dB
	EIRP	20.4	dBW
	Data Rate	9600	b/s

Space	Operating Freq	1.45E+08	Hz
	Wavelength	2.069	m
	Elevation	5	deg
	Earth Radius	6378	km
	Altitude	670	km
	Slant Range	2494	km
	Freespace Loss	143.6	dB
	Atmospheric Loss	1.0	dB
	Polarisation Loss	3.0	dB
Spacecraft	Boltzmann's Constant	-228.6	dB
	Feed Loss	1.0	dB
	Sky Temp	50	k
	Ground Temp	50	k
	Tant	100	k
	LNA noise figure	0.6	dB
	Tlna = Trx	43.0	k
	System Noise Temp	182.0	k
	VHF antenna gain	3.0	dB
	Gr/Tr	-20.6	dB
	Received Power	-75.2	dBm
	BER	1.00E-05	
	Received Eb/N0	41.0	dB
	Required Eb/N0	13.0	dB
	Margin	28.0	dB

5a5	A general description of any cipher system	A 4B packet key will be used. No formal encryption.
5b	Positive space station transmitter control. Explain how telecommand stations will turn off the space station transmitter(s) immediately, even in the presence of user traffic and/or space station computer system failure	The default state will be to transmit the amateur radio beacon however the primary OBC state machine can select multiple modes including ‘no beacon’ mode. This control has been demonstrated on AlSat-1N flight software. In the event of major failure, the transceiver can directly be configured to be held in permanent reset mode to fully turn off the radio transmitter and receiver. This would be end of life of the mission.
5c	Telecommand stations. List telecommand station(s)	
5c1 5c2	Amateur Radio Callsign	VU2RVJ
	Physical location (this is where the antennas are) lat/lon	Dept. of Aerospace Engineering, IIST, Valiamala(P.O.), Thiruvananthapuram, Kerala 695547
5d	Optional: Give the complete space station	The groundstation will update TLEs into both radio and rotator systems and will then

	turn off procedure.	autonomously command the TxOff command once every second. A visual inspection using 1) radio S-meters and 2) software defined radio frequency sweeps can confirm if successful. Groundstation can be remotely accessed during non-office hours.
6	**Telemetry (published)**	
6a	**Telemetry frequencies**	
6a1	All amateur telemetry frequencies or frequency bands	The mission is currently in the build phase and a full format will be published.
6a2	ITU emission designator	25kH F2D WN
6a3	Common description of the emission including modulation type AND data rate	FSK at 9600 bps
6a4	Radio Link budgets	

Downlink (UHF) @ 5 deg elevation			
Spacecraft	Transmit power	1	W
	UHF antenna gain	3.0	dB
	Feed loss	1.0	dB
	EIRP	2.0	dBW
	Data Rate	9600	b/s
Space	Operating Freq	4.37E+08	Hz
	Wavelength	0.686	m
	Elevation	5	deg
	Earth Radius	6378	km
	Altitude	550	km
	Slant Range	2206	km
	Freespace Loss	152.1	dB
	Atmospheric Loss	1.0	dB
	Polarisation Loss	3.0	dB
Ground Station	Boltzmann's Constant	-228.6	dB
	Feed Loss	4.9	dB
	Sky Temp	50	k
	Ground Temp	50	k
	Tant	100	k
	LNA noise figure	0.9	dB
	Tlna = Trx	66.8	k
	System Noise Temp	295.3	k
	UHF antenna gain	19.0	dBi

	Gr/Tr	-10.6	dB/K
	Received Power	-90.0	dBm
	BER	1.00E-05	
	Received Eb/N0	24.1	dB
	Required Eb/N0	13.0	dB
	Margin	11.1	dB

6b	Transmission formats	AX.25 (default) & Binary
7	**Launch plans (published)**	
7a	Launch agency	ISRO
7b	Launch location	Satish Dhawan Space Centre, India
7c	Expected launch date	2020
7d	Planned orbit.	
7d1	planned orbit apogee	550 km
7d2	planned orbit perigee	550 km
7d3	planned orbit inclination	97.6 deg
7d4	planned orbit period	95.4 min
7e	List other amateur satellites expected to share the same launch.	Unknown at time of submission

Earth station information:

8	**Typical Earth station — transmitting**	
8a	Describe the hardware and software of a typical Earth station used to transmit signals to the planned satellite	• Antenna system: 2x 19 elements VHF/UHF Yagi antenna. 16/19 dBi of gain, 20/30 deg BW • Preamplifier: N GaAs 435 MAS, typical noise figure 0.9 dB at UHF frequency band • RF front-end: a wide bandwidth transceiver that provides up to 100 mW of output power, and a typical noise figure of 5 dB. The local oscillators for the receive and transmit chains operate independently, which allows dual-band operation. • Digital section: Software Defined Radio USRP N210, including Xilinx Spartan 3A-DSP FPGA, operating from DC to 6 GHz • Amateur user groundstation downlink: Dipole with FUNcube Dongle or other FM receiver.
8b	Radio Link budget. Show complete link budgets for all Earth station transmitting frequencies, except telecommand.	See previous sections.
9	**Typical Earth station — receiving**	
9a	Describe the hardware and software of a typical Earth station to receive signals from the planned satellite.	See previous sections.
9b	Radio Link budget. Show complete link budgets for all Earth station receiving frequencies.	See previous sections.

Additional information:

Do not attach large files. Indicate the URL where the information is available.

10	Please, supply any additional information that may assist the Satellite Advisor to coordinate your request(s). *This is an ambitious international project that will be performing a number of world firsts and we want the amateur radio community to contribute to!*

Certification:

11*	☐ The licensee of the planned space station has reviewed all relevant laws, rules, and regulations, and certifies that this request complies with all requirements as understood by IARU to the best of his/her knowledge and confirms to meet the requirements of RR 1.56 and RR 1.57 in that the proposed satellite will operate without pecuniary interest. Please list any commercial interests. If none, please state none. **No commercial interests**
	☐ The licensee of the planned space station has reviewed all relevant laws, rules, and regulations and disagrees with IARU interpretations of Treaty requirements. The IARU Satellite Advisor is asked to consider the following interpretation. Explanation follows. **All treaties will be followed.**

Please tick ONE appropriate box.

Signature:

12	(REQUIRED!) _____ Signature of space station licensee. _____ Date submitted for coordination.