The International Amateur Radio Union

Since 1925, the Federation of National Amateur Radio Societies
Representing the Interests of Two-Way Amateur Radio Communication

FREQUENCY COORDINATION REQUEST

☐Tick here if this space station is also planned for amateur-satellite service operation.

Administrative information:

0	**DOCUMENT CONTROL**	
0a	Date submitted	04-JUNE-2014
0b	Document version number (start at zero and increment with each revised request)	0
1	**SPACECRAFT (published)**	
1a	Name before launch	Nodes
1b	Proposed name after launch	Nodes
1c	Country of license	United States of America
1d	Contact individual at your licensing authority and contact information	Federal Communications Commission Office of Engineering and Technology 445 12TH ST SW Washington DC 20554 Phone: +1-202-418-2470 Fax: +1-202-418-1944 E-mail: oetinfo@fcc.gov
1e	API/A number (to be forwarded if not available at time of coordination request)	Not Available

2	**SPACE STATION LICENSE (published)**	
2a	Experimental station call sign(s)	Not Available
2b	Licensee's name	Santa Clara University
2c	Representative's first (given) name	Christopher
2d	Representative's last (family) name	Kitts
2e	Postal address	Santa Clara University School of Engineering Department of Mechanical Engineering 500 El Camino Real Santa Clara, CA 95053
2f	Telephone number (including country code)	1 (408) 554-4382
2g	Representative e-mail address: our single point of contact who will receive all correspondence	ckitts@scu.edu

2h	Skype name (if available)	NA
2i	List names and e-mail addresses of *additional* people (up to three) who should receive copies of correspondence	R. Mike Rasay (rrasay@scu.edu)

Space station information:

3	**SPACE STATION (published)**	
3a	Mission(s) *Describe in detail what the space station is planned to do. Use as much space as you need.*	Nodes is a technology demonstration of a pair of low-cost 1.5U CubeSats in Low Earth Orbit (LEO) with advanced cross-link and downlink communications capability, suitable as a platform for Space Weather or other science applications requiring geographically distributed, synchronized data acquisition. Coordination is requested for one Stensat beacon transmitter per satellite, and one Microhard 2420 transceiver per satellite. The two satellites will be transported to the ISS aboard CRS-3 resupply mission.
3b	Planned launch date	Launch 03-OCT-2014; Deploy from ISS about Dec. 1 2014
3c	Planned mission duration	6 Months
3d	Proposed space station **transmitting** frequency[1] plan *List for each frequency band:* ➔ *frequency band (e.g. 435-438 MHz)* ➔ *indicate if operating frequency can be changed by telecommand and frequencies which may be used* ➔ *output power* ➔ *ITU emission designator[2,3]* ➔ *common description of the emission including modulation type AND data rate[4]* ➔ *antenna gain and pattern[5]*	***frequency band 1: 435-438 MHz:*** **We request coordination of the same frequency for both satellites: 437.1 MHz** Will not change frequency by telecommand 1 W 10k0F2D AX.25 over AFSK, 1200 baud Antenna Gain: -3dBi quarter wave monopole with a roughly semi-hemispherical emission pattern

[1] Show all frequencies **numerically** in MHz, or GHz. *Letter band designations are not used*.

[2] ITU emission designators are defined in Appendix I to the radio regulations. Effect of Doppler shift is NOT included when determining bandwidth.

[3] If using a frequency changing transponder, indicate the transmitting bandwidth. Effect of Doppler shift is NOT included when determining bandwidth.

[4] Common emission description means terms like transponder, NBFM, PSK31, 1200 baud packet (AFSK on FM), etc.

[5] Common patterns include omnidirectional, unidirectional (with a pattern).

	➔ *attitude stabilisation, if used*[6]	*attitude stabilisation:* Each of the satellites has active three-axis attitude control by means of three orthogonal reaction wheels and three orthogonal sets of two magnetorquer coils; and three-axis attitude determination.
	➔ *frequency band (e.g. 435-438 MHz)*	***frequency band 2: 2400 - 2450 MHz:*** **We request coordination of the same frequency for both satellites: 2401.2 - 2431.2 MHz**
	➔ *indicate if operating frequency can be changed by telecommand and frequencies which may be used*	Will not change frequency by telecommand.
	➔ *output power*	1 W
	➔ *ITU emission designator*[7,8]	350KF1D-
	➔ *common description of the emission including modulation type AND data rate*[9]	Spread Spectrum Frequency Hopping FM, FSK, *data rate 115.2 kbps*
	➔ *antenna gain and pattern*[10]	4.28 dB, dominant lobe radiation pattern
	➔ *attitude stabilisation, if used*[11]	Same as stated for frequency band 1.
3e	Proposed space station **receiving** frequency[12] plan. *List for each frequency band:* ➔ *frequency band* ➔ *indicate if operating frequency can be changed by telecommand and frequencies which may be used* ➔ *ITU emission designator*	See Telecommand frequency plan

[6] Unstabilized is a tumbler. Stabilized can be passive magnetic, spinner, three axis, gravity gradient, etc.
[7] ITU emission designators are defined in Appendix I to the radio regulations. Effect of Doppler shift is NOT included when determining bandwidth.
[8] If using a frequency changing transponder, indicate the transmitting bandwidth. Effect of Doppler shift is NOT included when determining bandwidth.
[9] Common emission description means terms like transponder, NBFM, PSK31, 1200 baud packet (AFSK on FM), etc.
[10] Common patterns include omnidirectional, unidirectional (with a pattern).
[11] Unstabilized is a tumbler. Stabilized can be passive magnetic, spinner, three axis, gravity gradient, etc.
[12] Show all frequencies **numerically** in MHz, or GHz. *Letter band designations are not used*.

	➔ *common description of the emission including modulation type AND data rate* ➔ *noise temperature* ➔ *associated antenna gain and pattern*	

4	**INTERNATIONAL** (published) Countries with international arrangments completed or anticipated.	None

5	**TELECOMMAND (NOT published)**	
5a	**Telecommand** frequency plan. *List:* ➔ *space station telecommand frequency bands,* ➔ *ITU emission designator(s)* ➔ *common description of the emission including modulation type AND data rate* ➔ *link power budget(s)* ➔ *a very general description of any cipher system*[13]	 2.4012 - 2.4312 GHz 350KF1D- Spread spectrum frequency hopping FM, FSK, Data rate 115.2 kbps. See Appendix Spread spectrum frequency hopping, precise frequencies and hopping pattern confidential.
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 failure.* ***NOTE:** Transmitter turn off control from the ground is absolutely required*. Software control is useful, but does not substitute for	Telecommand station will turn off UHF transmitter by commanding the command module to stop transmitting. If computer system fails amateur transmitter will not transmit. Each transmission must be specifically commanded by the computer system. System is specifically engineered so that loss of computer function results in no further transmissions. If telecommands are not received as expected, or if computer fails to operate properly, UHF transmitter

[13] Any means of preventing unauthorized telecommand of the space station. Recommended, but not required.

	telecommand. *Good engineering practice is to make telecommand independent of all other systems.* Be sure to read the paper: *Controlling Space Station Transmitters*.	will not be commanded by the computer system to operate.
5c	Telecommand stations. *List all telecommand stations. Sufficient Earth telecommand stations must be arranged before launch to insure that can be terminated immediately. See RR 22.1 and #3 of the terms and conditions above.*	Santa Clara University 3M Station, Santa Clara, CA, USA.

6	**Launch plans (published)**	
6a	Launch agency	Orbital Sciences Corp.
6b	Launch location	Wallops Flight Facility, Wallops Island, Virginia, USA
6c	Planned orbit ➔ *apogee* ➔ *perigee* ➔ *inclination* ➔ *period* *Include plans for orbit changes.*	 409 km 409 km 51.6 degrees 93 minutes None
6d	List other satellites expected to share the same launch. Update when more information becomes available.	Centennial-1, 449 Mhz

Earth station information:

7	**Typical Earth station — transmitting (published)**	
7a	Describe a typical telecommand station.	3M dish with Microhard 2420 transceiver.
7b	Link power budget. *Show complete link budgets for each Earth station transmitting frequency band.*	See Appendix.

8	**Typical Earth station — receiving (published)**	
8a	Describe a typical Earth station to receive signals from the planned satellite.	OSCAR Station.
8b	Link power budget. *Show complete link budgets for each Earth station receiving frequency band.*	See Appendix.

Additional information:

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

9	Please, supply any additional information to assist the Satellite Advisor to recommend frequencies for your mission(s). Desire frequency 437.1 MHz for both satellites UHF Desire 2.4012 - 2.4312 GHz for both satellites Microhard

Signature: ***Licensee agrees to IARU terms and conditions for coordination and represents that all information provided is true and correct.***

10	(REQUIRED!) _____ _____ Signature of licensee Date submitted for coordination

APPENDIX 1: Link Budgets

MHX 2420 Downlink and UHF Beacon Downlink

Parameter	MHX 2420	Comments		Beacon	Comments
RF Output Power (dBm)	30.26			31.13	
RF Output Power (W)	1.06			1.29	
Antenna Polarization	RHCP			Linear	
Spacecraft Misc. Loss (dB)	0.25			0.25	
Antenna Gain (dB)	6			2.2	
EIRP (dBW)	6.01			3.08	
Data Rate (Kbps)	115.2			1.2	
Modulation	FSK			AFSK	
Frequency (MHz)	244.5			437.1	
Propagation Loss (dB)	157.6	757 km (for 30deg elevation)		142.84	757 km (for 30 deg elevation)
Antenna Pointing Loss (dB)	0.6			4.7	
SC to Ground Antenna Polarization Loss(dB)	0.2			0.2	
Atmospheric Loss (dB)	1.1			0.3	
Received Isotropic Power (dBW)	156.09			147.38	
Ground Station Antenna Dish	3			Yagi	
Ground Station Antenna Polarization	RHCP			Linear	
Ground Station Antenna Gain	34.1			16.9	
Ground Station G/T (dBK)	7.2			9.077	
GS Antenna Pointing Loss (dB)	6.6			1	
Eb/No (dB) - received	22.495			41.351	
Eb/No (dB) - required	13.9			23	
Link Margin (dB)	11.195			20.771	

MHX 2420 Uplink

Parameter	MHX 20420 Uplink From SCU Ground Station to Nodes	Comments
Ground Station Radio RF out (W)	1	
Ground Station Antenna Gain (dB)	35	
Ground Station Losses (dB)	0	
Antenna Polarization	RHCP	
EIRP (dBW)	35	
Ground Station Elevation (degrees)	30	
Range (Km)	752	
Data Rate (Kbps)	115.2	
Modulation	FSK	
Frequency (MHz)	2412	
Propogation Loss (dB)	-157.58	752 km for 30 deg elevation.
Received Isotropic Power (dBW)	-122.58	
Spacecraft G/T (dB)	0.83	
Spacecraft losses (dB)	3	
Spacecraft Antenna Polarization	RHCP	
C/No (dB*Hz)	101.76	
Eb/No (dB) - received	51.14	
Eb/No (dB) - required	12	
Link Margin (dB)	41.23	