



### Outline of Clark sat-1 Project and changes from BIRDS original design

June 8, 2022

ArkEdge Space

https://arkedgespace.com/



## **Company Profile**

Company name	ArkEdge Space Inc.		
Date of establishment	July 18, 2018		
Location	Tokyo, Japan		
Capital	18 MUSD (including capital reserve)		
Main Business	<ul> <li>Design, manufacturing, and operation service of spacecraft (nanosatellites), ground stations and related components.</li> <li>Software development, education and consulting services.</li> </ul>		
Main customers	<ul> <li>Rwandan Utilities Regulatory Authority</li> <li>NSPO(National Space Center of Taiwan)</li> <li>University of Tokyo, Fukui</li> <li>Seiren Co.</li> <li>Space BD</li> <li>Shoko Chukin Bank, Ltd.</li> <li>Mitsui Sumitomo Bank, Ltd</li> </ul>		
Legal advisor	Uchida & Samejima Law Firm		



- Completed graduate school at The University of Tokyo.
- Founded ArkEdge Space in 2018
- JICA expert and official at the Ministry of Foreign Affairs and the Cabinet Office's National Space Policy Secretariat.

Founded in 2018 to commercialize nanosatellite technologies in collaboration with "**University of Tokyo**"

### [Our Vision] "Providing infrastructure for an era where anyone can conduct business by satellite"



## **Main Achievements**

#### We launched a first satellite for Rwanda



Reported to Rwandan President Kagame at the Transform Africa Summit

#### Awards

- Won the Special Jury Prize at S-booster 2017
- □ Selected as a venture support project by NEDO/NEPA
- Adopted as "Asia-Pacific Ocean Satellite Data Service Platform Construction Project" by the Cabinet Office's FY2018
- Adopted as constellations project for FY2021 by Ministry of Economy, Trade and Industry



**Received an order from Taiwan NSPO** (National Space Center in Taiwan) to manufacture, launch and operate a 6U satellite platform from in 2022.

![](_page_2_Figure_12.jpeg)

About us

![](_page_3_Picture_1.jpeg)

#### SOSHI Educational Group

Clark Memorial International High School

![](_page_3_Picture_4.jpeg)

https://seg.ac.jp/english/about/group\_en/clark More than 10,000 students at 50 campus

O	ur Philosophy
Fr	om Chair of the Board
O	ur History
0	verview
	- Kobe Office
	- Tokyo Office
	- New Zealand Office
	- Hawaii Office
	- Vietnam Office
O	ur Group

- Japan's largest correspondence high school
- Named after William Smith Clark, Who was a professor and leader of agricultural education in the late 19th century. His words to students became a nationally known motto in Japan 'Boys, be ambitious.'
- Combining daytime schooling with correspondence programmes.

#### フッタ(資料名など)

![](_page_4_Picture_0.jpeg)

## **Project structure**

![](_page_4_Figure_2.jpeg)

### Clark sat-1 Satellite

![](_page_5_Picture_2.jpeg)

![](_page_5_Picture_3.jpeg)

![](_page_6_Picture_0.jpeg)

### Lithium-ion Battery

![](_page_6_Picture_2.jpeg)

#### Clark sat-1 Ground Station (JS1YIZ)

![](_page_7_Picture_2.jpeg)

### Definition of Amateur Satellite Service

![](_page_8_Picture_2.jpeg)

#### AMATEUR SATELLITE FREQUENCY COORDINATION REQUEST INSTRUCTIONS AND APPLICATION FORM

1. Amateur-satellite service. Amateur stations meet the requirements of the radio regulations, RR 1.56. and 1.57.

**RR 1.56** *amateur service:* A *radiocommunication service* for the purpose of self-training, intercommunication and technical investigations carried out by amateurs, that is, by duly authorized **[licensed]** persons **[individual natural people]** interested in radio technique solely with a personal aim **[for themselves]** and without pecuniary interest **[compensation]**. (NOTE: Explanatory terms in brackets are not part of the treaty text.)

**RR 1.57** *amateur-satellite service:* A *radiocommunication service* using *space stations* on earth *satellites* for the same purposes as those of the *amateur service*.

Why we use Amateur band for CubeSats?

- Easy to get a license and permission in 2000s.
- Not expensive on-board communication board (Some suppliers like Addnics, Nishi-musen ...)
- Amateur VHF / UHF transceivers and antennas are available in markets.
- No Power Flux Density (PFD) limit for Amateur band. ITU-RR
- Expectation of CubeSat signal reception by amateur radio operators.

JAS-1 (FO-20) launched in 1986 Copy right: JAXA

Amateur radio community was generous until around 2010. But recently, it is getting difficult to pass IARU judges.

![](_page_10_Picture_0.jpeg)

## IARU application of Clark sat-1

	Space station mission and frequency			
5.1	Type of mission? Tick applicable box(es):	<ul> <li>Amateur</li> <li>Amateur combined with Educational</li> <li>Amateur combined with other mission(s)</li> </ul>		
5.2	If mission type in given in 5.1 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?	□yes, see 5.3 ☑no		
5.3	If you' ve answered yes in 5.2, please explain:	N/A		

		ArkEdgeSpace
	Space station mission and frequency	
5.4	List and describe the project mission(s):	Clark sat-1 is a 1U size satellite, and about 22 students of Clark Memorial International High School having amateur radio qualification or intending to obtain it will be engaged in the development of the satellite, and operate it by using the amateur radio band.
		1. Optical Camera Mission
		To take pictures of the Earth and downlink them in 430 MHz band (GMSK, 4,800 bps). The pictures are to be received at control station and general amateur stations are also expected to receive them and report to us as the downlink schedule will be published on our website and social media.
		2. Digi-talker Mission
		40 to 120 seconds long Digi-talker signal (Voice or SSTV pictures in Robot 36 format recorded before launch) including the call sign and school name will be transmitted from the satellite and be expected that the general amateur stations will receive the signal and report back to us.
5.5	Explain in plain text how your mission(s) complies with provisions no. <b>1.56</b> , <b>1.57</b> and <b>25</b> (see <u>Annex 1</u> ); how will your mission contribute to the advancement of the amateur satellite service; and how will amateur operators around the globe be able to participate in your mission, besides just receiving the satellite telemetry?	High school students will be engaged in the development of the satellite, and high school students with amateur radio license will operate the satellite. These activities will improve the amateur radio and satellite communication skills of the students. The project will also serve as a model case for the development of amateur satellites by the younger generation, and stimulate the interest of the younger generation in amateur radio and satellite communications. The satellite information, such as orbital position and operation time, will be actively disseminated to the world through the website and social media, so that radio amateurs all over the world will have an opportunity to receive image data and digi-talker signals transmitted from the satellite.

## Link budget calculation

A link budget spread sheet is at: <u>http://www.amsatuk.me.uk/iaru/spreadsheet.htm</u> The spreadsheet is prepared by Jan A. King, W3GEY.

I would like to recommend you to use the spreadsheet, and not to use your own.

![](_page_12_Figure_4.jpeg)

![](_page_13_Picture_0.jpeg)

### Response from IARU Satellite Advisor

Date: 28 February 2022

То

Dear

In response to your coordination request IARU has coordinated the following frequencies for **Clark sat-1**.

for downlink 435. MHz with emission designators 500HA1A, 16K0F1D, 16K0F3E and 16K0F3F, maximum EIRP 29.1 dBm.

For uplink MHz with emission designator 16K0F1D.

Licensing administration: Japan

Planned launch date Q1 2023.

Planned Height and Orbit: Apogee 419 km, perigee 410 km, inclination 51.6 degrees, period 92.6 min.

Telecommand station: JS1YIZ.

IARU has coordinated frequencies in bands allocated to the amateur satellite service. All frequencies in the amateur satellite service are shared frequencies.

Please inform me about the final launch date and the API/A number as soon as that information becomes available.

Best wishes for a successful project.

HP.Bhanderd

Hans Blondeel Timmerman IARU Satellite Advisor

![](_page_14_Picture_0.jpeg)

Ministry of Internal Affairs and Communications (MIC, 総務省) Land Mobile Communication Division (移動通信課)

Experiment Plan (実験計画書)

This document needs to submit for internal process of MIC.

Mainly, they check following points.

- Fit to Amateur Satellite Service of RR1.56 and 1.57
- Minimum uplink margin to avoid interference (Earth Station)
- Minimum Occupied Band Width to avoid interference (Satellite)

### 実験計画書

#### 【Clark sat-1衛星を用いた教育活動】

改訂	改訂日時	改訂箇所
Ver1.0	令和4年3月17日	初版
Ver1.1	令和4年3月30日	3.3,4.3 (記載例)を削除 5.1 表2 区分を開設に修正 F3Fの占有周波数帯域幅 5.4 表2 F3EとF3Fの占有周 波数帯域幅の根拠
Ver.1.2	令和4年3月30日	表紙 申請者所属 4.2 実験計画(予定) 誤字修正 5.4 表2 F3Eの占有周波数帯 域幅の根拠
Ver.1.3	令和4年5月25日	2.1 地球局にUHFトランシー バー従系 を追加

## Occupied Band Width: Calculation or Measurement

## Calculation

![](_page_15_Figure_3.jpeg)

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Maximum modulation frequency (M):3kHz
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D=5kHz, k = 1

![](_page_16_Figure_1.jpeg)

(3) F3F (SSTV)

RECOMMENDATION ITU-R SM.328-8 SPECTRA AND BANDWIDTH OF EMISSIONS P18 3.8.1.1 (10)

https://www.itu.int/dms\_pubrec/itu-r/rec/sm/R-REC-SM.328-8-199407-S!!PDF-E.pdf OBW=2M + 2Dk = 2 x 2.85kHz + 2 x 5kHz x 1 = 15.7 kHz

Maximum modulation frequency (M) : 2300Hz + 550Hz = 2.85kHz

SSTV modulation

White : 2300Hz, Black 1500Hz, Horizontal Sync 1200Hz,

Max deviation +/-550Hz

D=5kHz, k = 1

## Clark sat-1 mission

(1) Optical camera

Same as BIRDS-3

- (2) Digi-talker (Voice & SSTV) We had two options to realize it.
- (a) To modify ADDNICS COM board

![](_page_17_Picture_6.jpeg)

(b) Additional COM board using a handy talkie module SA828-U 400-480MHz FM 1W TRX

![](_page_17_Figure_8.jpeg)

![](_page_18_Picture_0.jpeg)

	Original COMM board	ADD1468AAZ (MOD version)
UTX, UBTX		
Frequency	Need to order in 435-438MHz band	Need to order in 435-438MHz band
Transmitting Power	GMSK 0.8W CW 0.1W	GMSK 0.8W CW 0.1W FM 0.8W
GMSK bit rate CW OBW FM frequency deviation	4800bps < 400Hz N/A	4800bps < 400Hz 3kHz
URX		
Frequency	Need to order in 435-438MHz band	Need to order in 435-438MHz band
GMSK bit rate	4800bps	4800bps

![](_page_19_Figure_1.jpeg)

![](_page_20_Picture_1.jpeg)

![](_page_21_Picture_0.jpeg)

# Conclusion

 (1) Explained Clark sat-1 project
 (2) Shared tips on IARU application and MIC Experiment Plan
 (3) Showed changes of COM board Adding Digi-talker function (Voice &SSTV)

We are looking for experienced engineers. Working place is in Tokyo, Japan and need Basic Japanese conversation skill.

https://open.talentio.com/r/1/c/arkedgespace/homes/2770

![](_page_22_Picture_3.jpeg)