Open Source CubeSat Workshop 2018
European Space Astronomy Center (ESAC), Madrid, Spain

24 / 25 September 2018

Development and Present Status of PocketQube in Nepal [Nepal-PQ1]

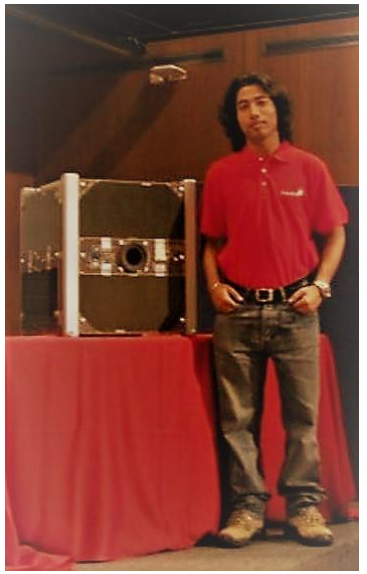
PRAJAPATI Rakesh Chandra

Founder/CEO ORION Space

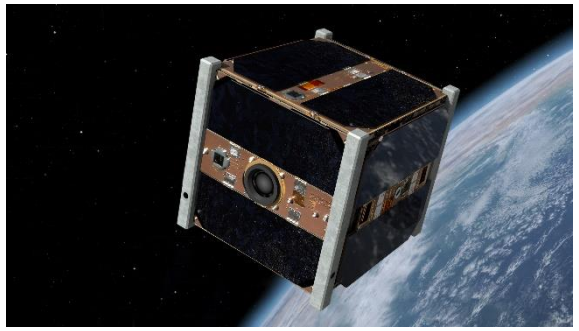
Rakesh Chandra PRAJAPATI

10 years of experience in R&D (Research and Development), SI (System Integration), V&V (Verification and Validation), AIT (Assemble, Integrate, and Testing) in Biomedical and Space Engineering.

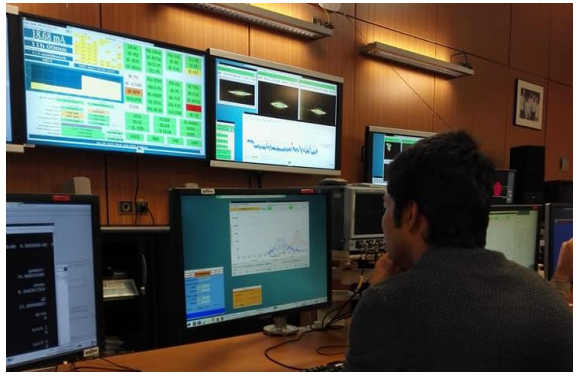
- Founder/CEO of **ORION Space**
- Masters in Electronics and Space Technology from **EPFL**, Switzerland (2007 - 2010)
- SwissCube – **CubeSat** Launched in 2009
- Interest in **Physics and Geometry**



SwissCube CubeSat Launch
23-09-2009, EPFL

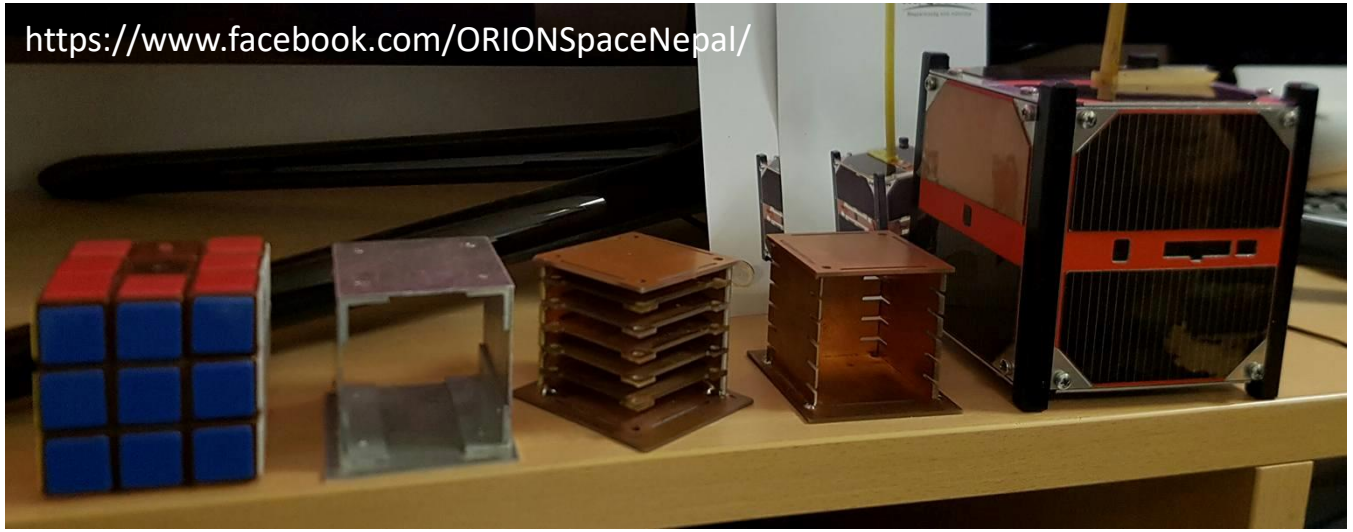


SwissCube- CubeSat, EPFL



Pico/Nano-Satellites

- Pico/Nano-Satellites
  - ***CanSat (model of satellite) in 1998***
  - ***CubeSat (10cm x 10cm x 10cm, 1kg) in 1999***
  - ***PocketQube (5cm x 5cm x 5cm, 250g) in 2009***



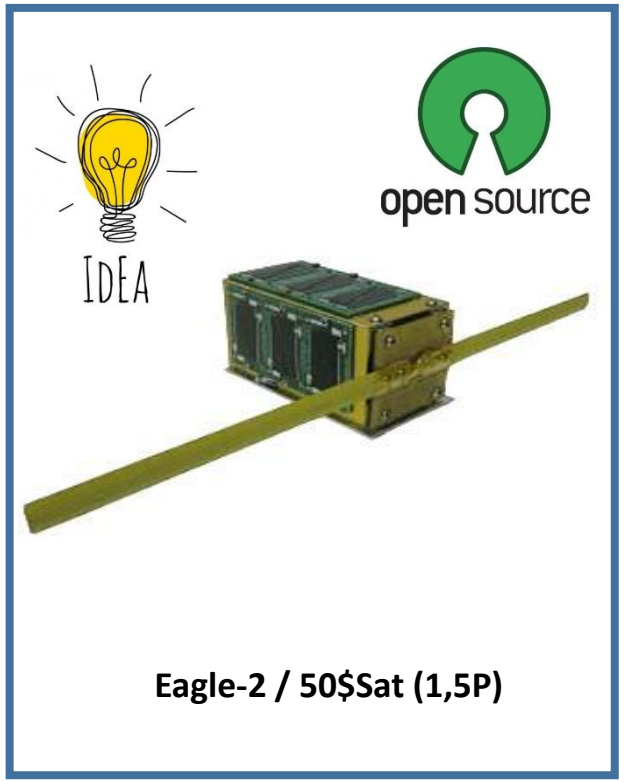
Group name	Mass (kg)
Large satellite	>1000
Medium satellite	500 to 1000
Mini satellite	100 to 500
Micro satellite	10 to 100
Nano satellite	1 to 10
Pico satellite	0.1 to 1
Femto satellite	<0.1

Pico-Satellite: PocketQube

- PocketQube
  - 1P is 5cm x 5cm x 5cm Cube Satellite
  - 250 grams
- Advantages of Pico/Nano-Sat
  - Affordable for University Project
  - Private Company Project
  - Capacity Building

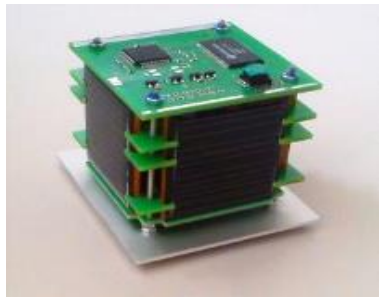
EduQube Kit by PicoSat Systems

First PocketQubes Launched in 2013

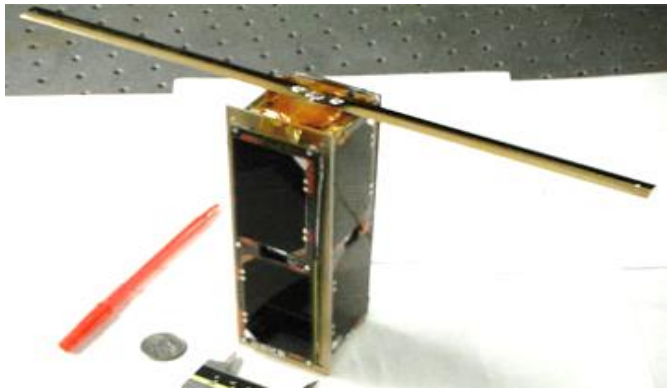


Eagle-2 / 50$Sat (1,5P)

Eagle-1 / T-LogoQube (2,5P)



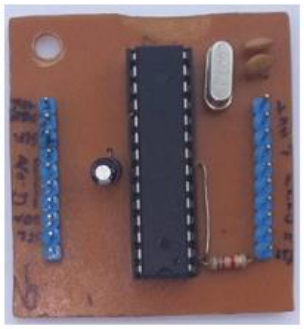
Wren (1P)



QBScout (2,5P)

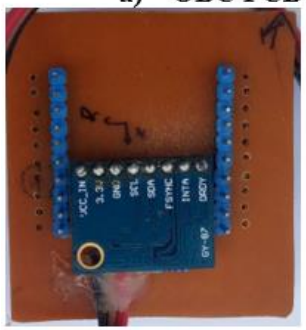
Let’s Start with Small

Started with CanSat Project

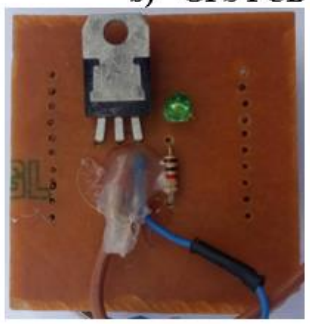


a) OBC PCB

b) GPS PCB

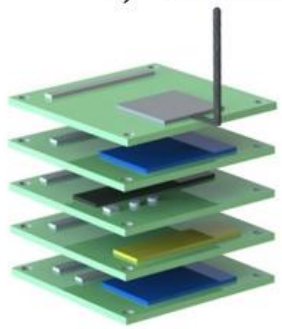


c) Payload PCB



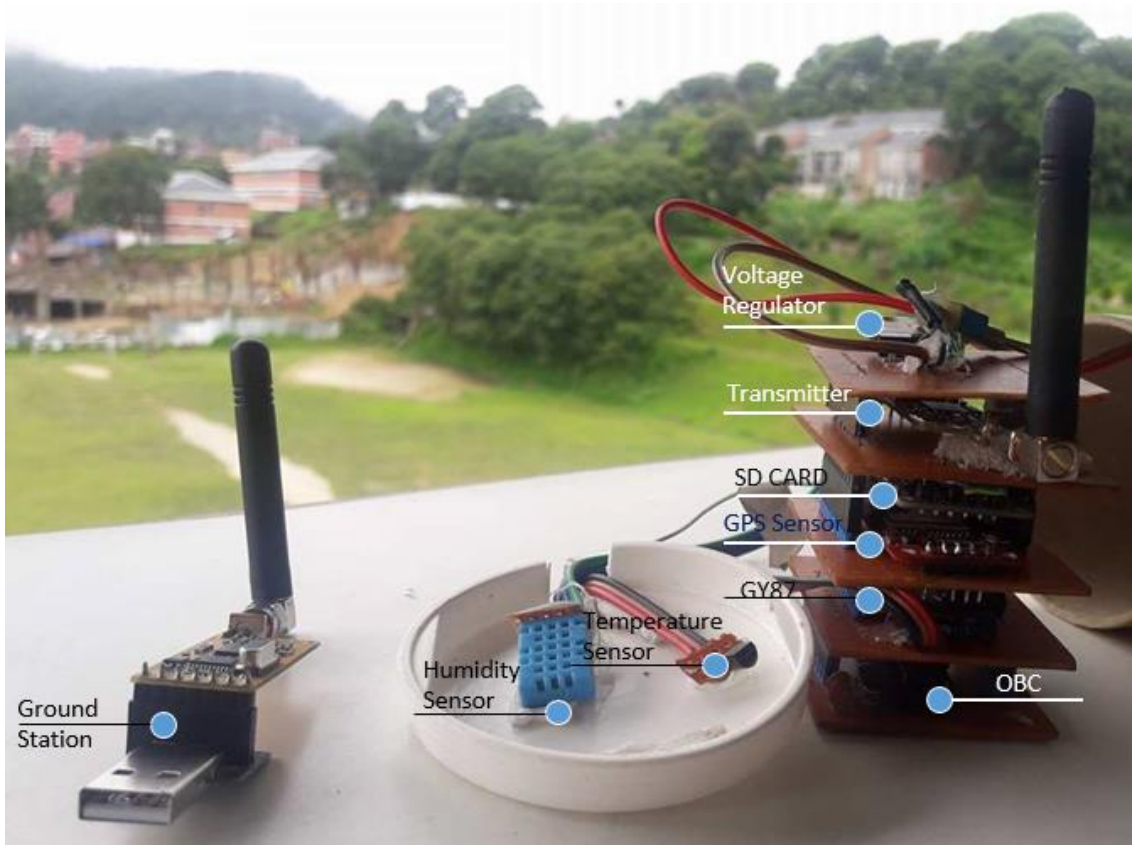
d) EPS PCB

e) COM PCB



f) CanSat 3D Model

(Stacked)



Stackable PCBs of CanSat Sub-Systems

1st Prize: Winner of Swiss-Nepal Technology Transfer 2017
Best Academic Project at Kathmandu University 2017

ORION SPACE

Papers Related to CanSat Published in International Conferences

MARS Summit 2017, 24-26 February. ACS Engineering College, Bangalore, India

Development of CanSat Ground-Station using LabVIEW

Saurav Paudel[1, 2*], Rakesh Chandra Prajapati[1†], Jiten Thapa[1, 2], Safal Shrestha[1, 2], Abinish Kumar Dutta[1, 2], and Sanjeeb Humagain[1, 2]
[1]*ORION Space, Nepal*
[2]*Kathmandu University, Nepal*
*saurav.paudel@student.ku.edu.np, †rakesh_chandra.prajapati@alumni.epfl.ch

8th International Conference on Recent Advances in Space Technologies (RAST)

CanSat based Pico-Satellite Development Activities at Kathmandu University, Nepal

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68th International Astronautical Congress (IAC), Adelaide, Australia,
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IAC-17-E1.3.6

Development of CanSat Kit for Undergraduate Space Education in Nepal

Rakesh Chandra Prajapati[a]*, Abinish Kumar Dutta[a,b], Sanjeeb Humagain[a], Saurav Paudel[a,c], Jiten Thapa[a,c], Safal Shrestha[a,c]

[a] *Pico/Nano-Satellite Research and Development Lab, ORION Space, Kathmand*
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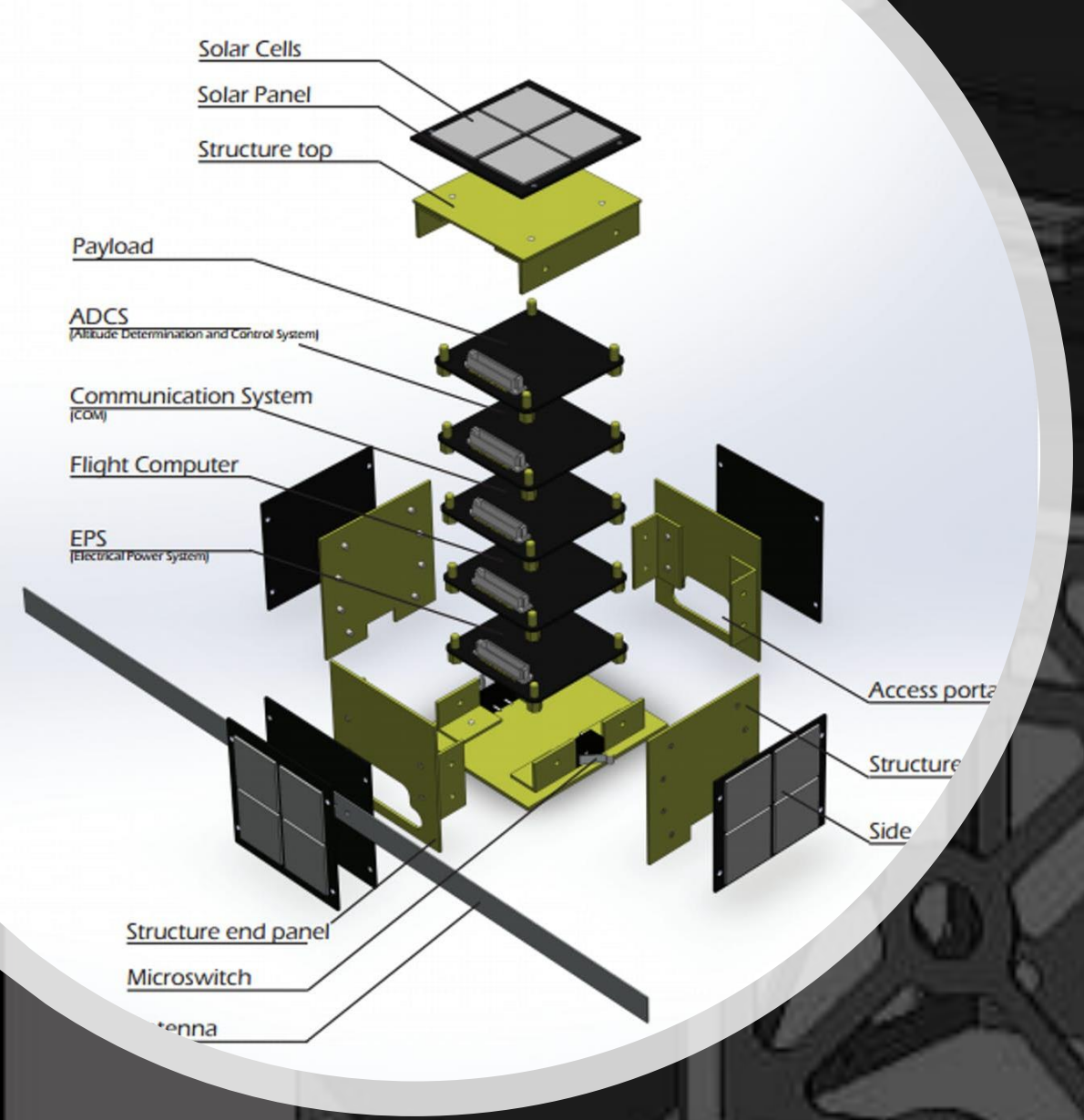
[c] *Department of Electrical and Electronics Engineering, Kathmandu University,*
* Corresponding Author

Introducing CanSat for Project Based Learning (PBL) of Space Science and Engineering in Nepal

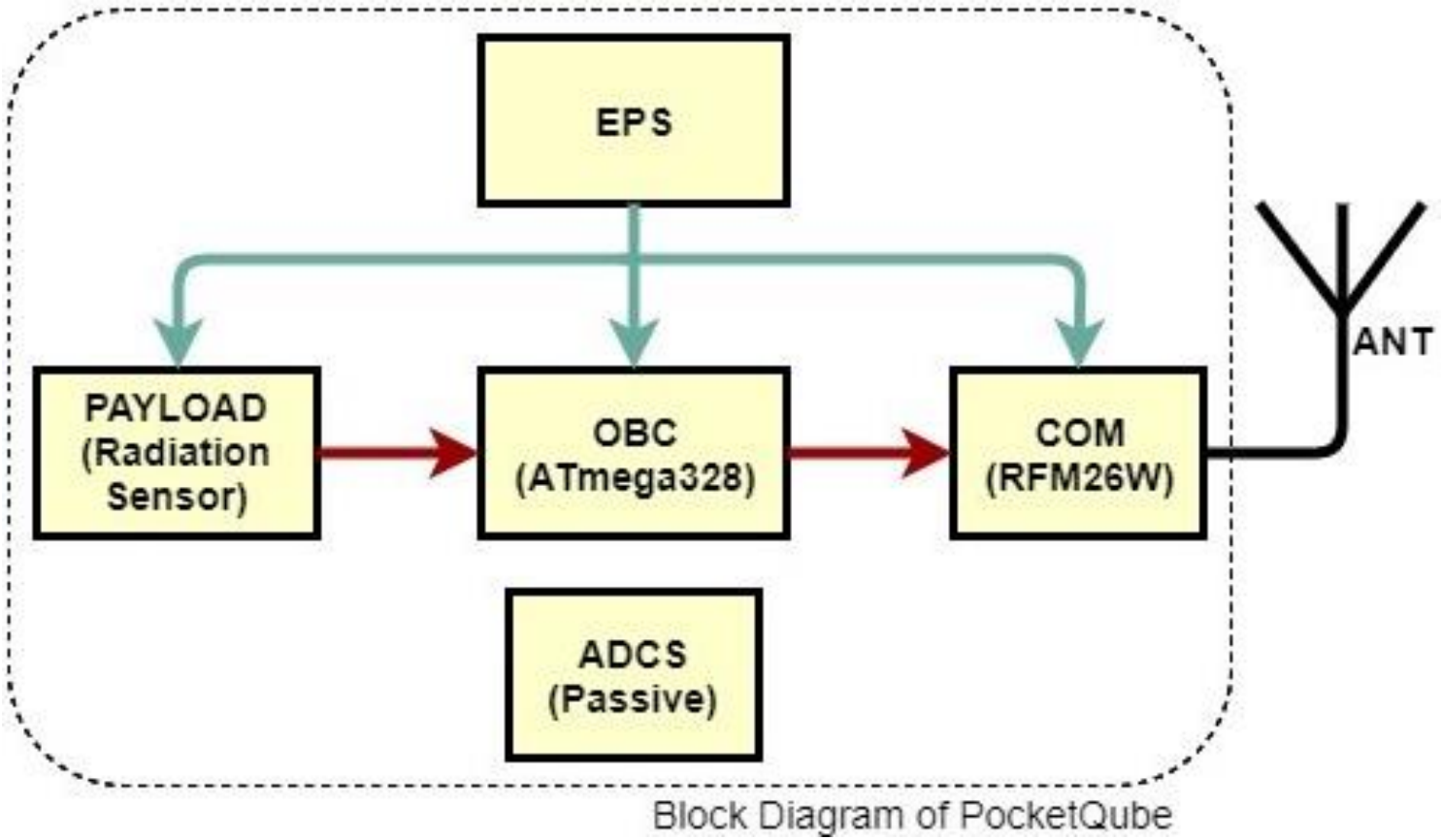
By Rakesh Chandra PRAJAPATI,[1)] Abinish Kumar DUTTA,[1),2)] Sanjeeb HUMAGAIN,[1),2)] Saurav PAUDEL,[2)] Jiten THAPA,[2)] and Safal SHRESTHA[2)]

[1)]*Pico/Nano-Satellite Research and Development Lab, ORION Space, Kathmandu, Nepal*
[2)]*Department of Electrical and Electronics Engineering, Kathmandu University, Dhulikhel, Nepal*



Why PocketQube?

- What NEXT after CanSat?
- Potential Users
  - Education
  - Research
  - Commercial
- Application
  - Education and Training
  - Science
- Early Career Development
  - Next generation engineers



Block Diagram of PocketQube

Block-Diagram of Nepal-PQ1

- *EPS: Electrical Power System*
- *OBC: On-Board Computer*
- *ADCS: Attitude Determination and Control System*
- *COM: Communication System*

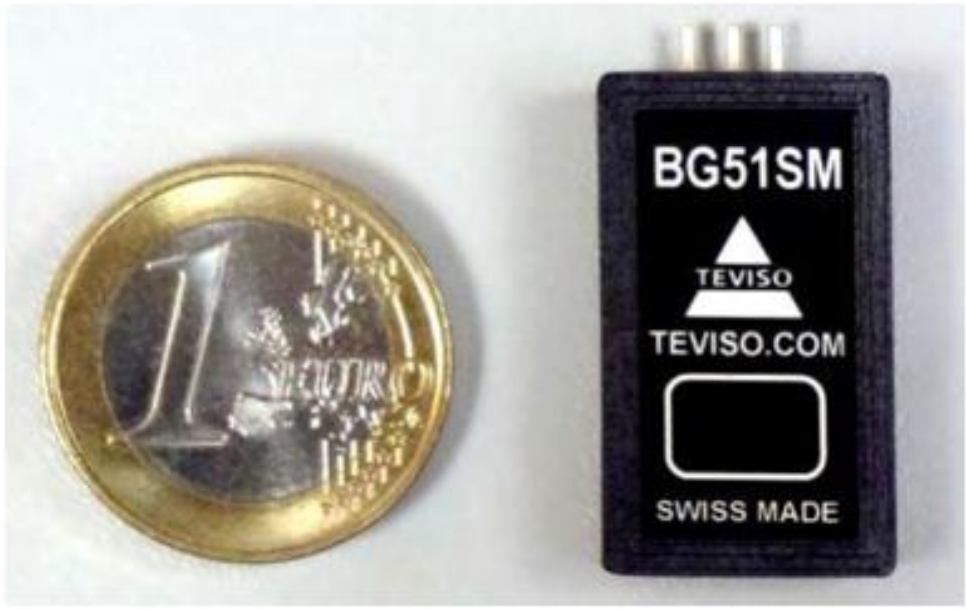
Mission and Payload Selection

Selected a **mission** which does not require any pointing mechanism.

Find a **payload** which consumes less power, fits in a small volume, and does not require pointing mechanism.

Payload

Ultra-low power (3.3 V, 25µA) and small size (31.5mm x 16mm x 7mm) radiation sensor ‘BG51-SM’.



The sensor sends CPS (count per second) to the OBC.

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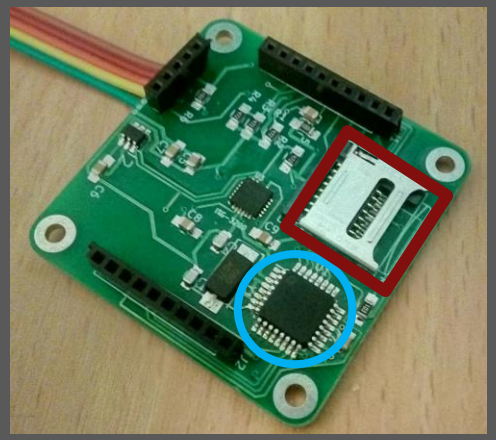
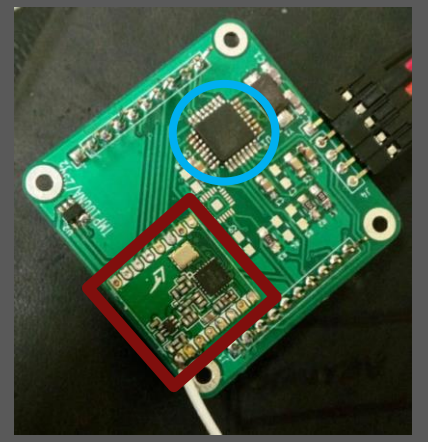
- We decided to use the ATmega328p 3.3V chip for OnBoard Computer (OBC) system, which we had experience from the earlier **CanSat project**.

- We decided to use RFM26W 20dBm (100mW) for COM, which is based on Si4463



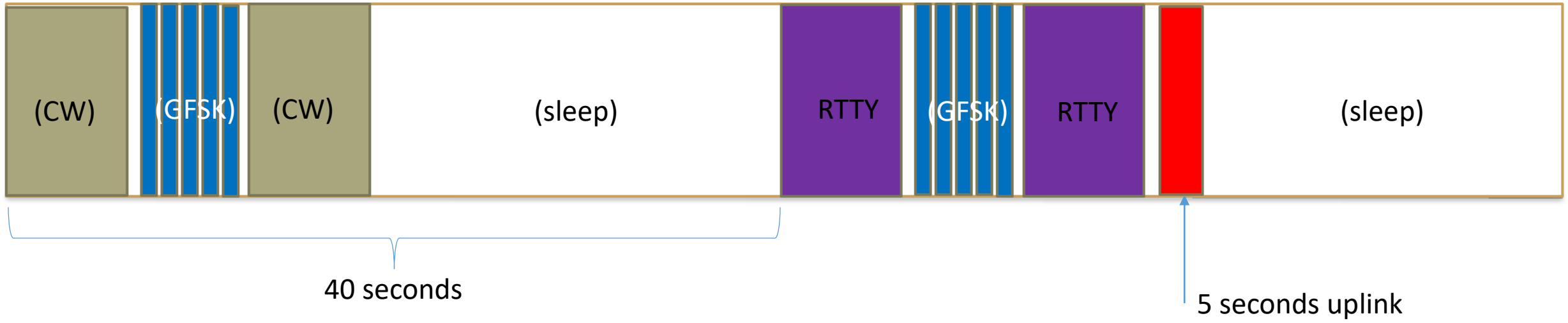
1st Iteration



2nd Iteration

3rd Iteration
With external
watchdog

On-Board Computer (OBC) & COM Board



RTTY FSK : 50 Baud, ID + Housekeeping (All Payload)

CW Morse : 20 WPM, ID + Temp + Current + Voltage

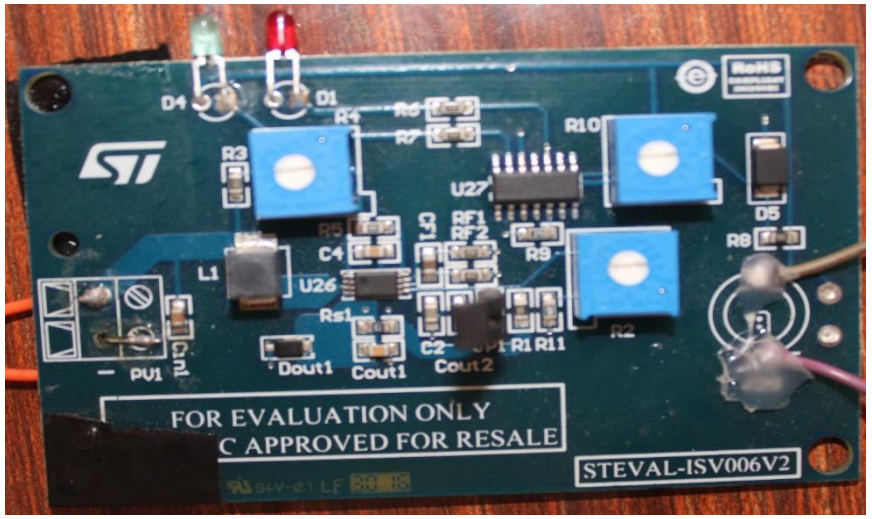
GFSK Downlink: 1200bps, RFM26 packet structure with payload

GFSK Uplink: 1200 bps, RFM26 packet structure with commands

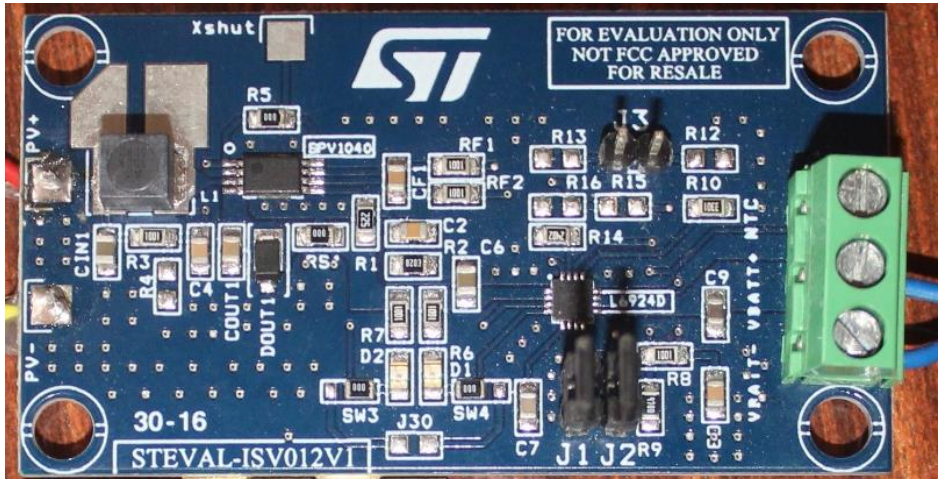
Communication Mode and Time Division Multipluxing

Electrial Power Supply

SPV1040
High efficiency solar battery charger with embedded MPPT



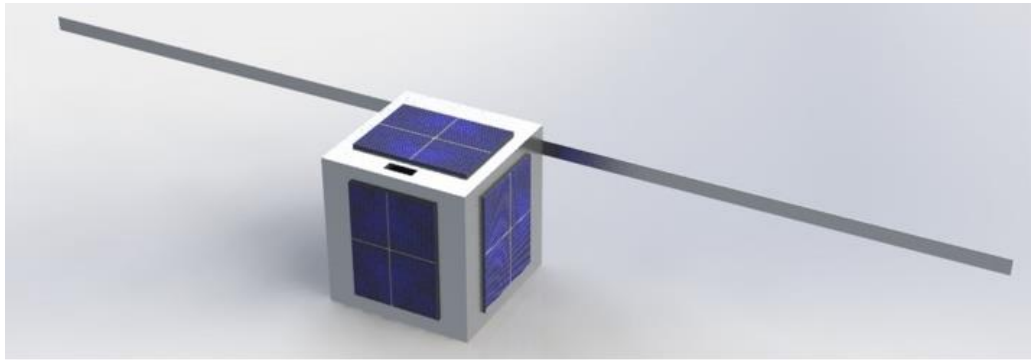
STEVAL-ISV006V2



STEVAL-ISV012V1

PocketQube Cost & Time

- Hardware Development by ORION Space
  - Need support for Launch cost (25k USD)
- Two engineers and Internship students
  - Salary 200 USD per month for one engineer
- Our Science Mission
  - Store and Forward sensor data
  - Measure the Space radiation
- Our Mission Time
  - To launch within 2 years



Render of Nepal-PQ1

COST ESTIMATION		
Hardware Development	10k	USD
Assembly, Integration, and Test	5k	USD
Thermal Vacuum and Vibration Test	5k	USD
Ground Station Building	5k	USD
Launching PocketQube to LEO	25k	USD
Total	50k	USD

Chassis by Joseph Hinchliffe

Challenge of building PocketQube

- Limited **volume** for payload
  - 1P = 5cm X 5cm X 5cm
- Limited **power** for operation
  - 250mW
- Start with teaching and preparing the man-power, and then start building it!

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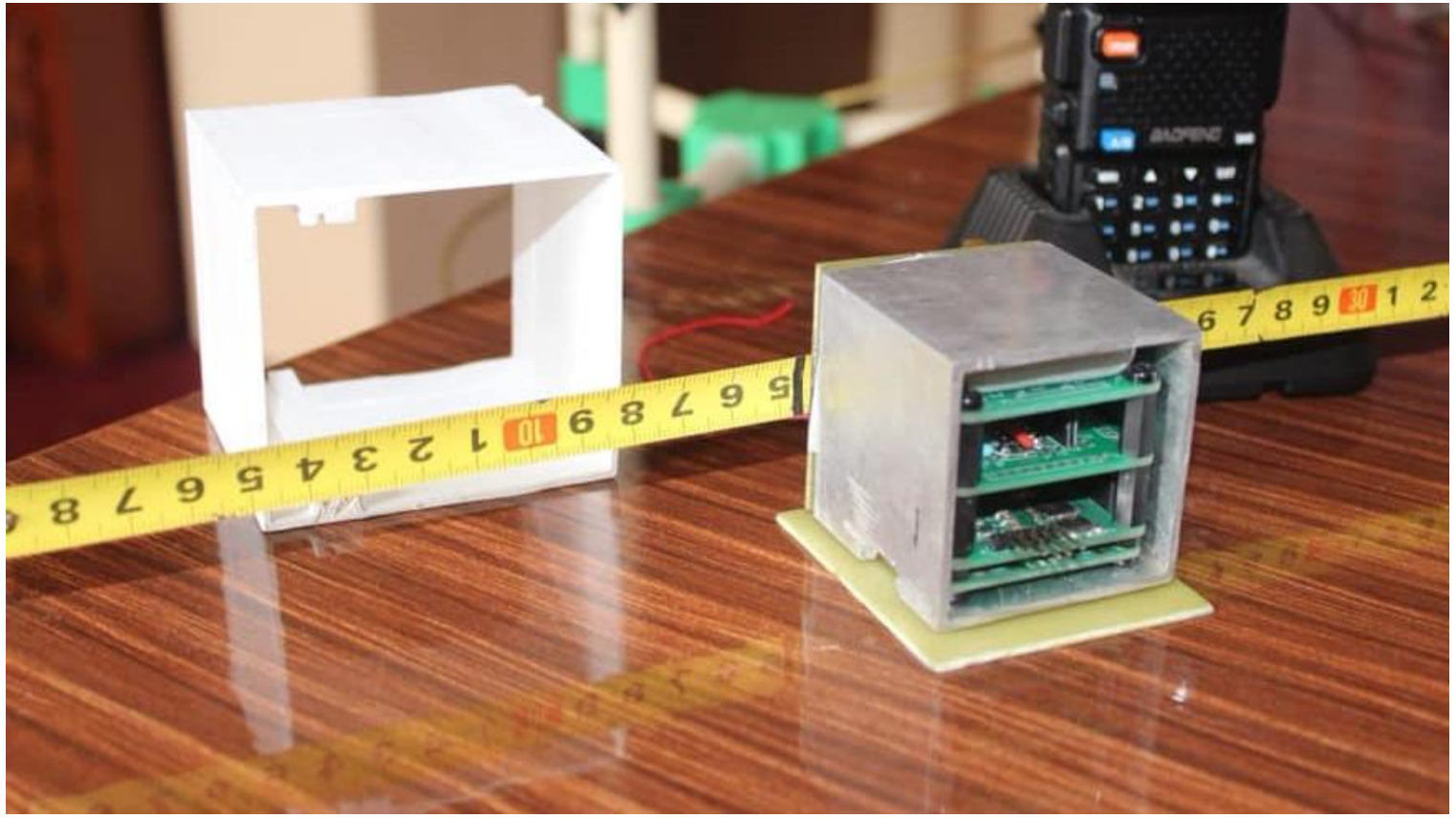
Prototype of Nepal-PQ1

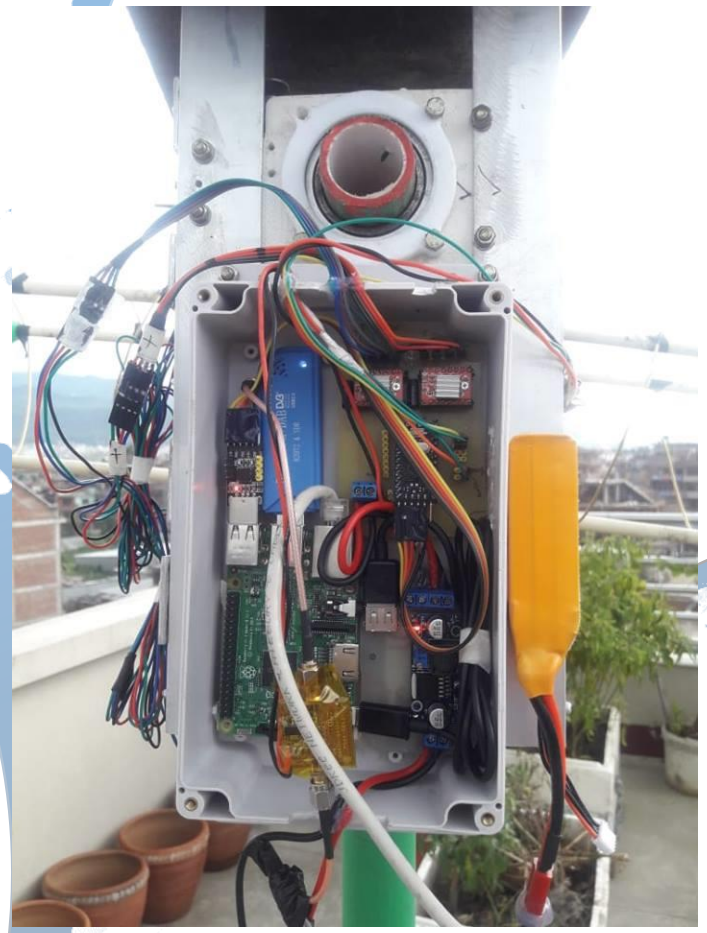


Ok, PQ is a cheaper Pico-Satellite Project

BUT

What is a cheaper Ground Station?

SatNOGS



open source

SatNOGS Ground Station

ORION SPACE

176 - Nepal-PQ1 Orion Space

Edit | Delete

Owner	Jiten Thapa
QTH Locator	NL27rq
Coordinates	27.677°, 85.439°
Altitude	100 m
Min Horizon	10°
Antennas	UHF Helical
Observations	30 View all
Creation Date	1 month, 3 weeks ago
Client version	0.7
Testing	Last seen 0 minutes ago
Uptime	57 days, 20:07:49 Log

Your Station is in Testing mode. Once you are sure it returns good observations you can put it online.

SatNOGS GS in Nepal (ORION Space)

ORION SPACE

Paper Published on PocketQube

1st IAA North East Asia Symposium on Small Satellites
21 – 23 August 2017Ulaanbaatar, Mongolia

Development of Student's Pico-Satellite Based on PocketQube Standard for Space Radiation Measurement

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Stuart McAndrew
PicoSat Systems
Perth, Australia

Saurav Paudel, Jiten Thapa, Safal Shrestha, Ritesh Pathak, Abishek Kafle, Sijan Shrestha, Rashila Shrestha, Yaju Rajbhandari, Ranjeet Kafle, Shayarrn Khatiwoda
School of Engineering
Kathmandu University
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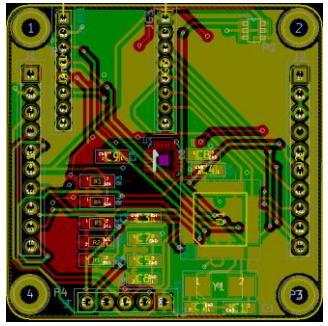
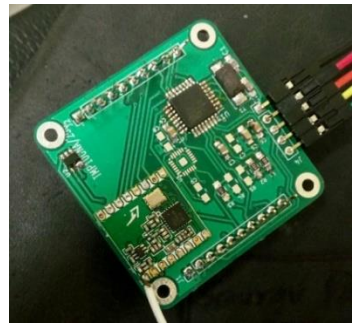
Rikesh Bhattrai
Department of Physics
Tribhuwan University
Kritipur, Nepal

ORION Space

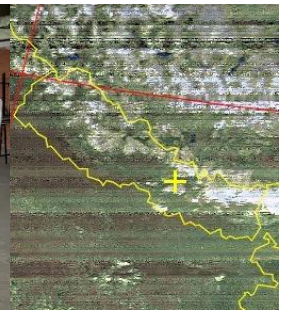
- **What is our Goal?**
  - **Promote Space Education**
  - Space Engineering and Technology
  - **Training and Workshop**
- **Why ORION Space?**
  - **Capacity Building**
  - Technology Demonstration
  - Technical Development
- **Motivation?**
  - **Space Job Opportunity in Nepal**



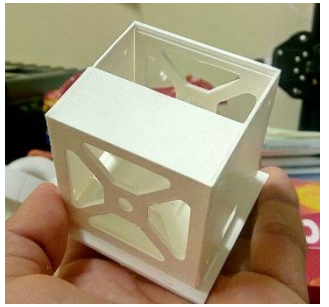


PocketQube's PCBs Development at ORION Space

Ground Station Development



Antenna Workshop and NOAA Weather Satellite Image



3-D Print Structure

CanSat

Training in Japan, 2016

ESL Award in Australia

Training in Korea, 2018

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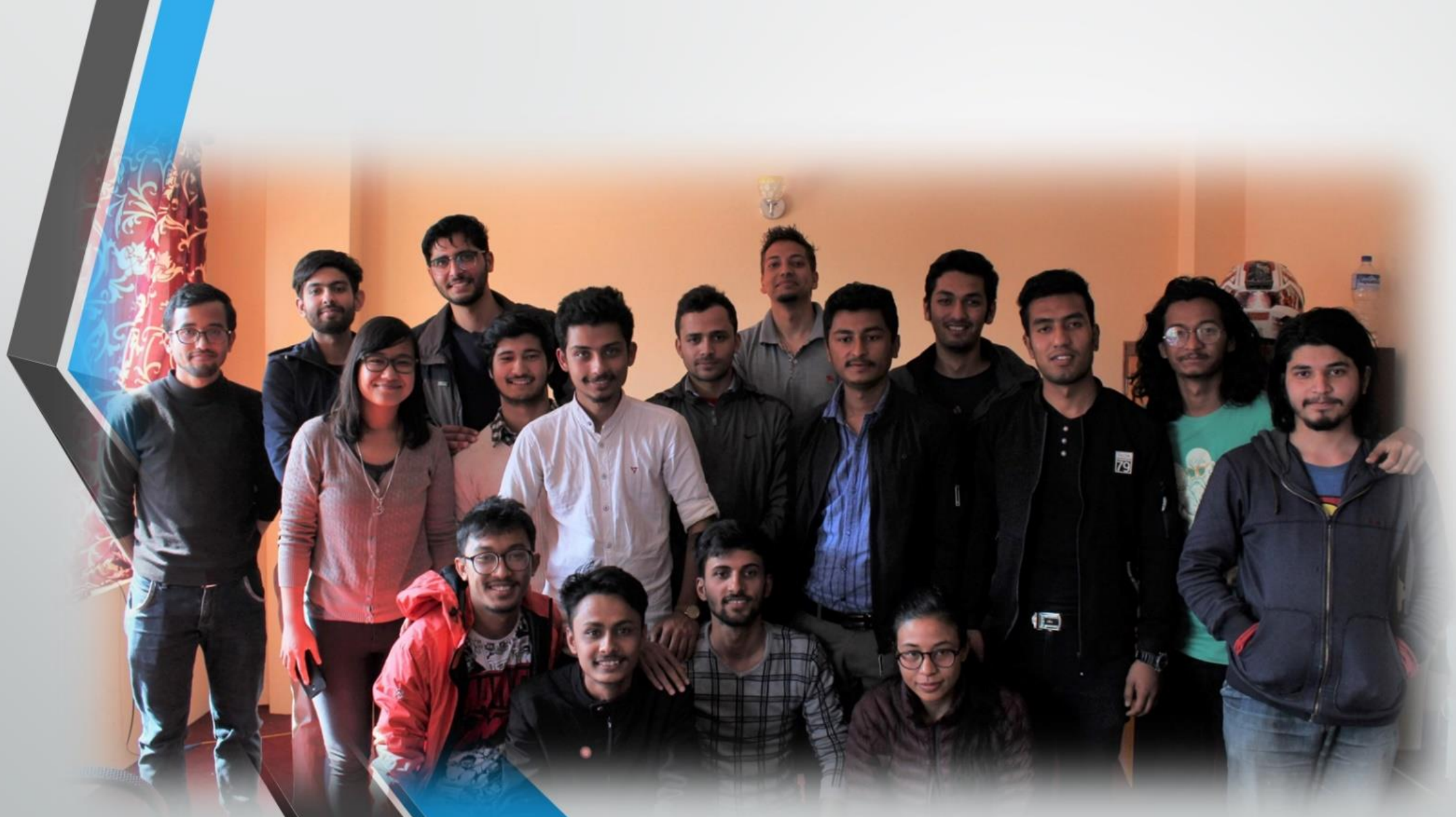
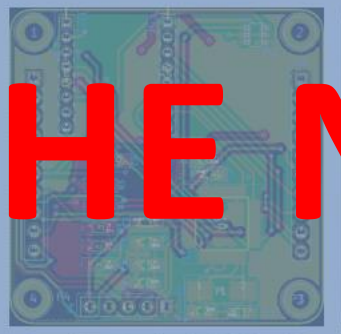


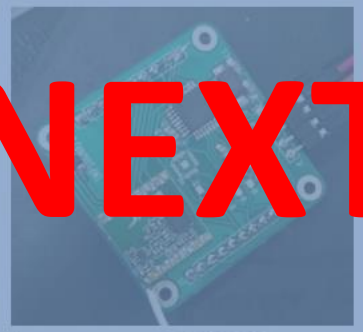
ORION Space – Team 2018

ORION Space

INSPIRE THE NEXT GENERATION OF ENGINEERS

- What is our Goal?
  - Promote Space Education
  - Space Engineering and Technology
  - Training and Workshop
- Why ORION Space?
  - Capacity Building
  - Technology Demonstration
  - Technical Development
- Motivation?
  - Space Job Opportunity in Nepal





Ground Station Development

Antenna Workshop and NOAA Weather Satellite Image

3-D Print Structure

CanSat

Training in Japan, 2016

ESL Award in Australia

KARI
한국항공우주연구원
Korea Aerospace Research Institute

Training in Korea, 2018

ORION SPACE

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CH02 0024 3243 4607 5540 R

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