بسم الله الرحمن الرحيم

AS-COMSAT-1 - Administration Report 2021

Planning & Control 2020 – 22

Author:

Dr. Samir Mourad

Last update: Thursday, January 27, 2022

Name of document:

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Content

1 Official company papers

Actually the German based company TEMO e.K. and two institutes of Istanbul Marmara university are official stakeholders.

All necessary official actions as launch coordination and HW procurement shall be done with TEMO e.K.

After finishing of investment phase a official Turkey based company AS-COMSAT shall be founded.

1.1 TEMO e.K., Germany

Handelsregister A des Amtsgerichts Mannheim	Abteilung A Wiedergabe des aktuellen Registerinhalts Abruf vom 31.08.2018 20:43	Nummer der Firma: **HRA 104902**
	Seite 1 von 1	

1. **Anzahl der bisherigen Eintragungen:**

   1

2. **a) Firma:**

   TEMO Soft-, Hardware & Consulting e.K.

   b) Sitz, Niederlassung, inländische Geschäftsanschrift, Zweigniederlassungen:

   Karlsruhe

   c) Gegenstand des Unternehmens:

   ---

3. **a) Allgemeine Vertretungsregelung:**

   ---

   b) Inhaber, persönlich haftende Gesellschafter, Geschäftsführer, Vorstand, Vertretungsberechtigte und besondere Vertretungsbefugnis:

   Inhaber: Mourad, Samir, Karlsruhe, *12.09.1969

4. **Prokura:**

   ---

5. **a) Rechtsform, Beginn und Satzung:**

   Einzelkaufmann

   b) Sonstige Rechtsverhältnisse:

   ---

   c) Kommanditisten, Mitglieder:

   ---

6. **a) Tag der letzten Eintragung:**

   17.10.2006

2 Banking account

2.1 Banking account of TEMO e.K.

Banking account:

TEMO e.K., Kto.Nr. 9214763, BLZ 67250020, Sparkasse Heidelberg, Germany

TEMO e.K., IBAN DE46672500200009214763 , SWIFT-BIC SOLADES1HDB

Bank: Sparkasse Heidelberg, Germany

3 AS-COMSAT & Partners Facilities

3.1 Bureau in Heidelberg/Germany (TEMO)

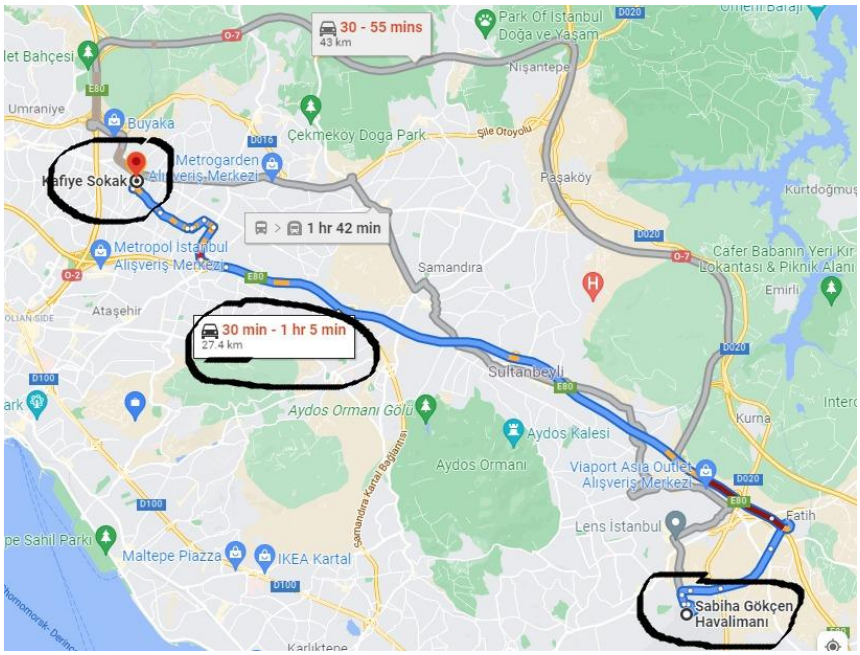
3.2 Contact bureau & Engineering in Istanbul (planned)

[19:46, 1/25/2022] Samir Mourad: 3000TL oder 200 Euro für Miete

Erdgas 400TL (~25 Euro), Strom 250TL (~10 Euro), Kalt Wasser 100TL (~6 Euro), Internet 155TL (~11 Euro), Insgesamt ungefaehr 250Euro

[19:46, 1/25/2022] Samir Mourad: https://goo.gl/maps/2tNKYdmc2fPnNifY9

2 rooms (1 bureau, 1 private room) + kitchen + bath room



3.3 Laboratories at Marmara University

…

3.4 AECENAR Laboratories

Ras Maska/Tripoli, www.aecenar.com

Electronic Lab, Vacuum Chamber (to be completed)

4 Predevelopment Studies 1999-2005, 2012-2020

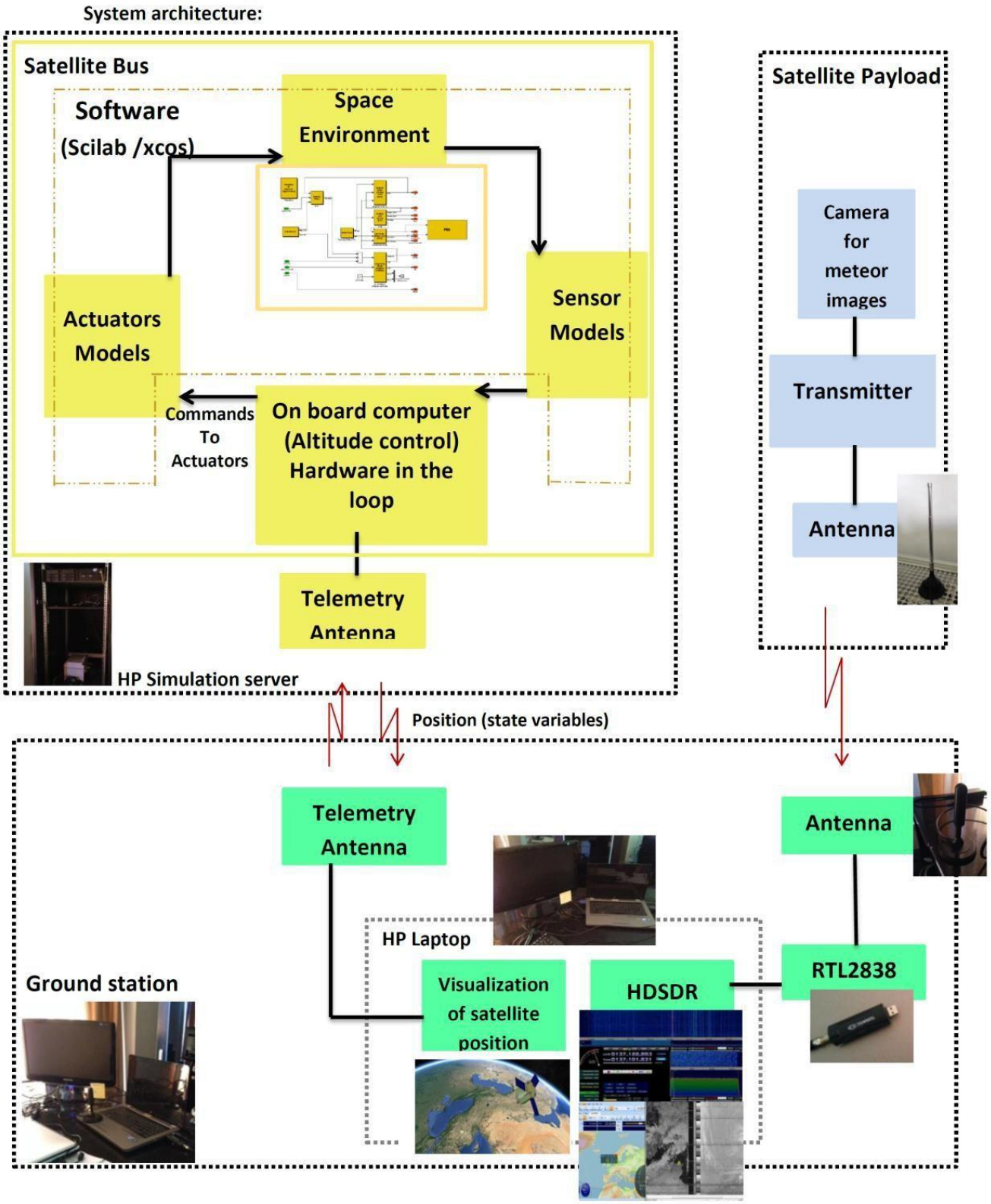
Costs: about 180 k$

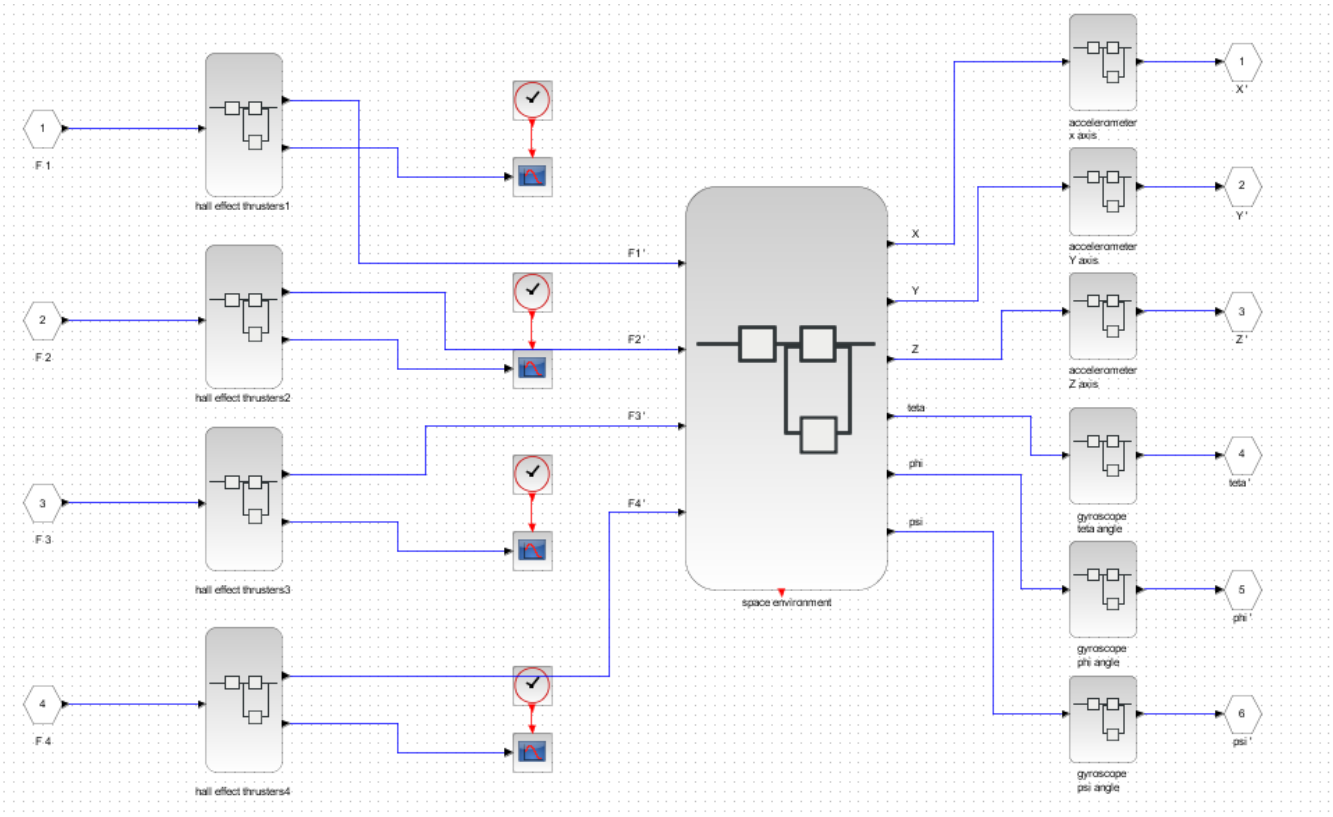
Open Tasks

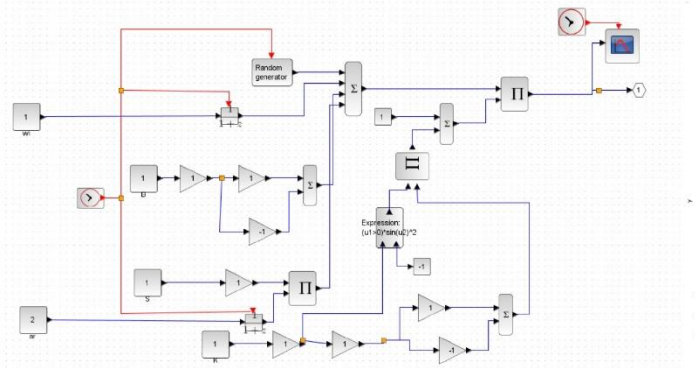
Tasks	Needed Human Resource	External Cost	Year
TEMOLeb-Mintad Gas filling	2 Technicians, 4 MM (man months)	5000$	2019
TEMOLeb-Mintad& TEMOLeb-SAT solar panels and system	-	2000$	2019
TEMOLeb-Mintad Control System development & Validation (simulink/scilab)	Eng., 5 MM	400$	2019
TEMOLeb-Mintad Actuators, Wings integration	2 Technicians, 2 MM	1000$	2019
TEMOLeb-Mintad Sensors integration	Eng., 1 MM	300$	2019
TEMOLeb-SAT Actuator (chem.)	1 Technician, 1 MM	1500$	2019
TEMOLeb-SAT Platform integration	1 Technician, 1/2 MM	500$	2019
TEMOLeb-Mintad Telemetry Unit	2 Eng., 6 MM	3000$	2020
TEMOLeb-SAT Telemetry Unit	2 Eng., 6 MM	3000$	2020
TEMOLeb-Mintad COM Unit (Payload)			2020
TEMOLeb-SAT COM Unit (Payload)			2020

@AECENAR – ICS May2019 MMJZ
www.aecenar.com/index.php/institutes/ics

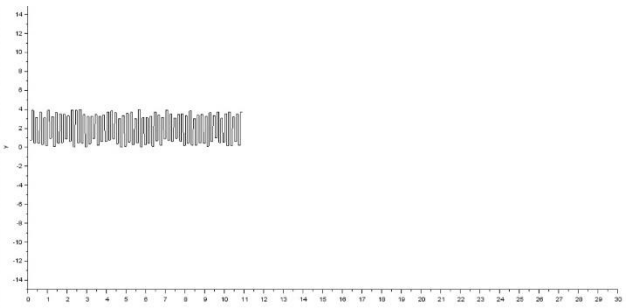
Hardware-in-the-Loop test rig for IAP-SAT (Overview)







After simulation:



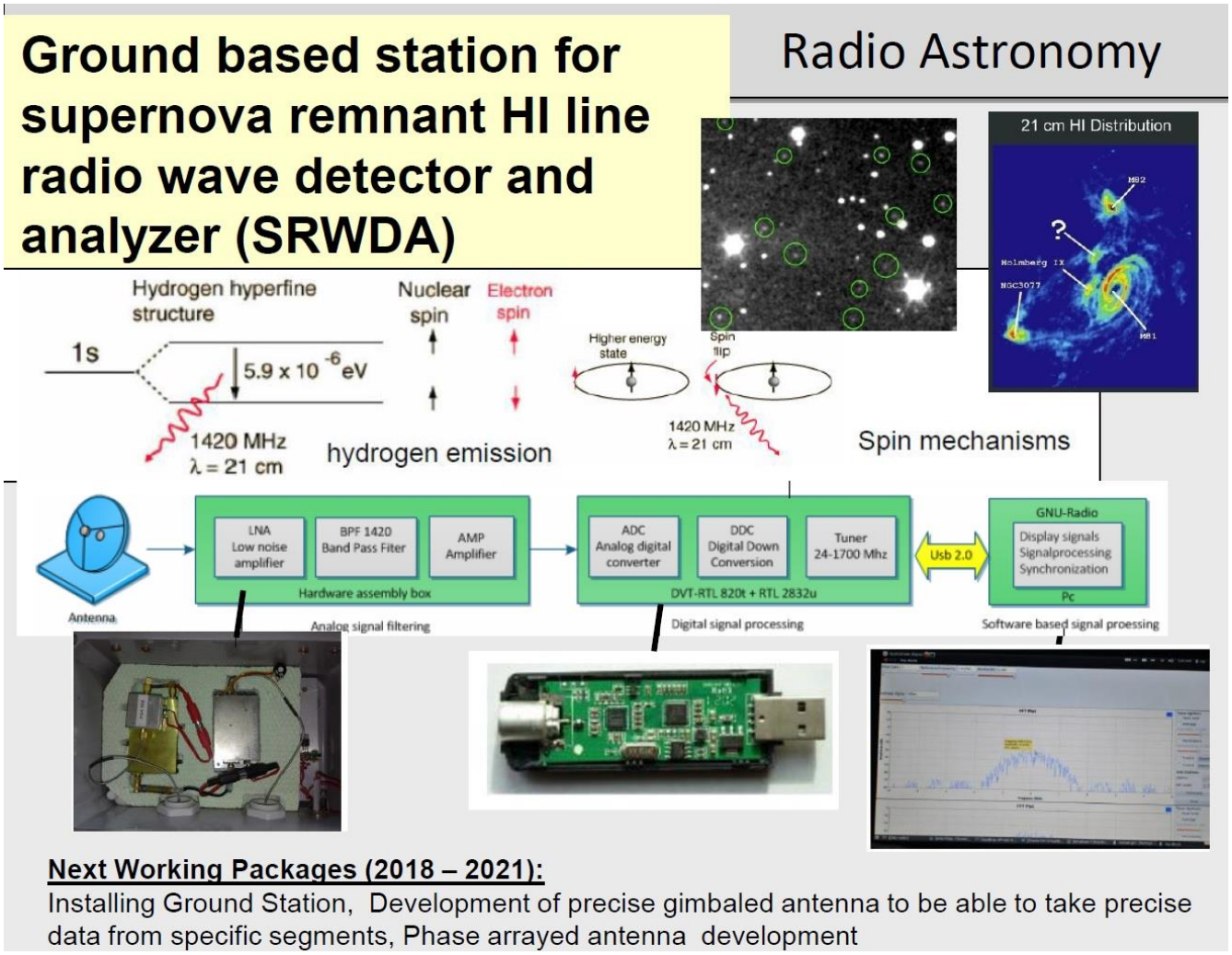
In this figure, input 1 is the angular speed wi, and imput 2 is the acceleration. These inputs is passed by the scale factor, the noise, transfer function and the misalignement of the axis to measure the final angular speed as output of gyroscope.

Overview is including Simulation model of actuators, space model and sensors of IAP-SAT (for 1. xcos model, 2. Graphs of simulation results please refer to documentation)

- Interface between Simulation Server and Board Computer of IAP-SAT (for 1. xcos model, 2. Graphs of simulation results): please refer to documentation)

- Meteorological Images supply by HDSDR

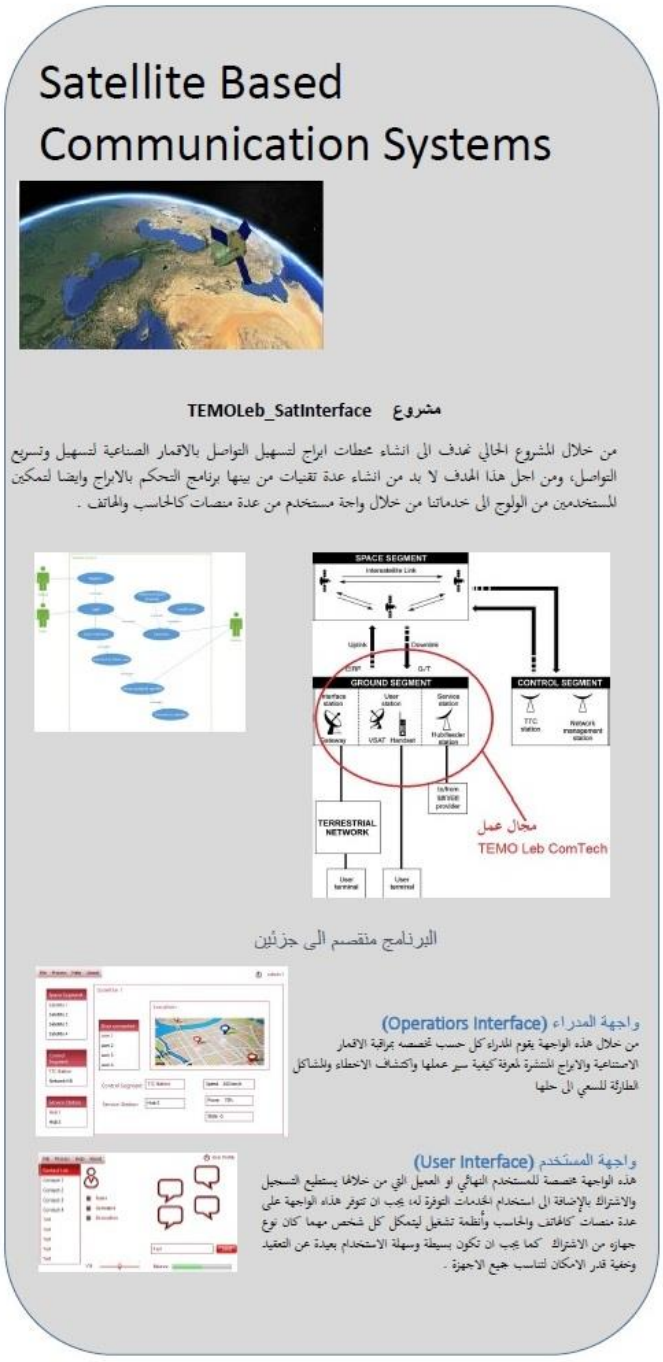
Payload Radioastronomy Sensor

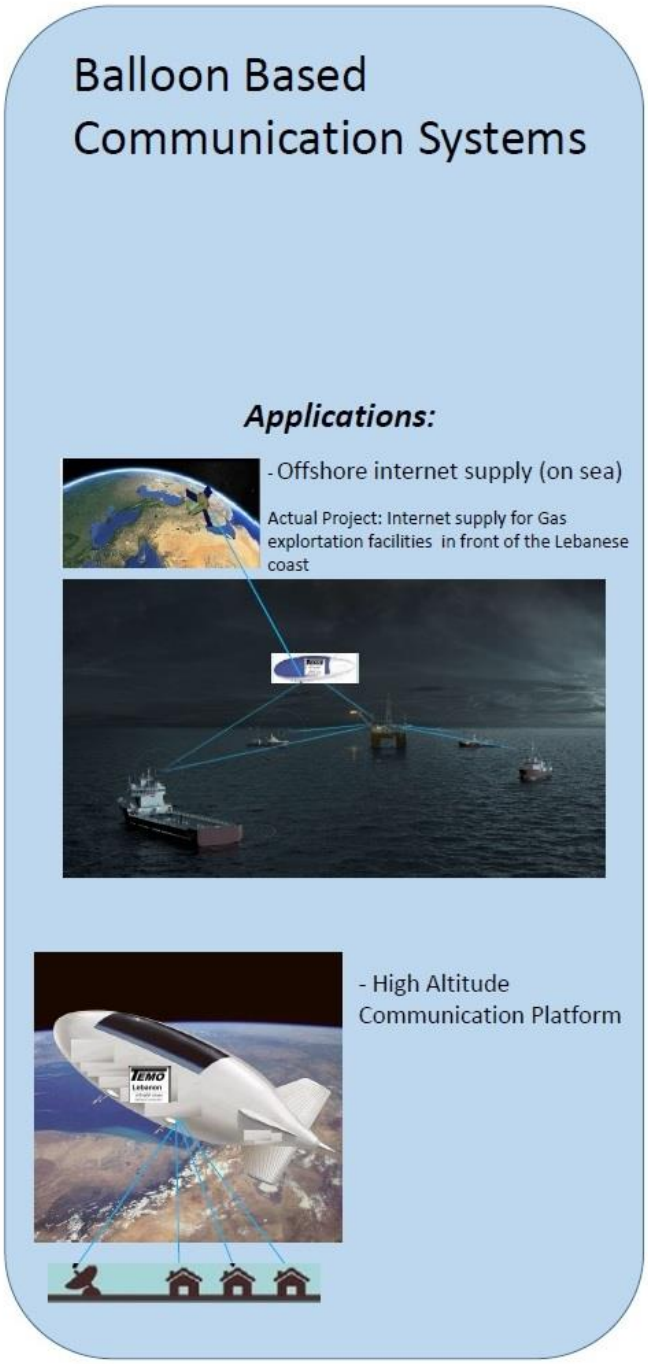


See AECENAR IAP-SAT Final Report (2013-2020), http://aecenar.com/index.php/downloads/send/10-iap/664-iap-sat-final-report-2012-2020-pdf

5 Business Plan/Marketing: Plans for different Projects

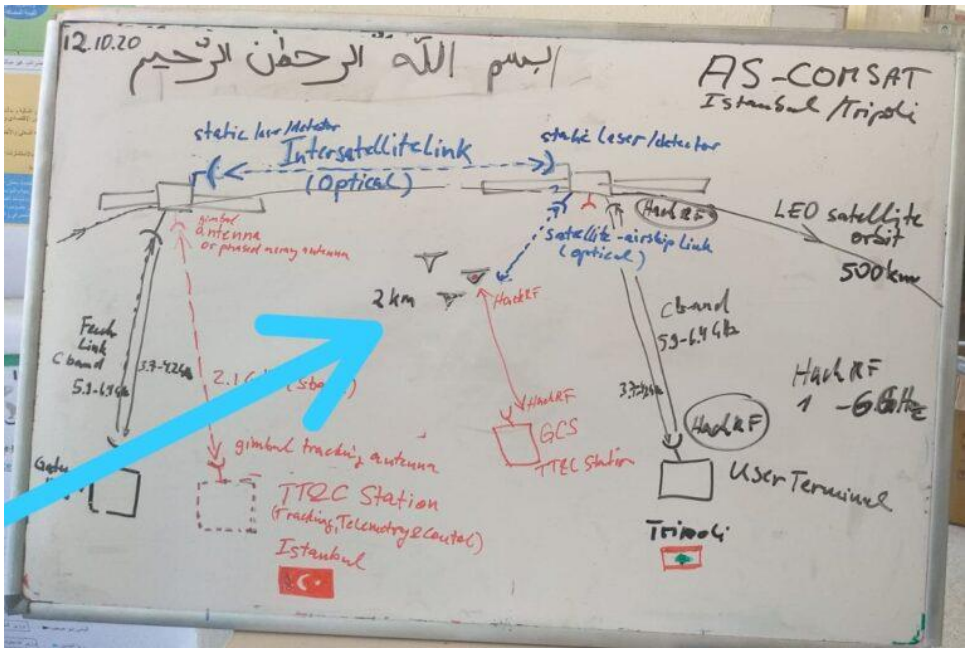
5.1 Satellite-airship COM system

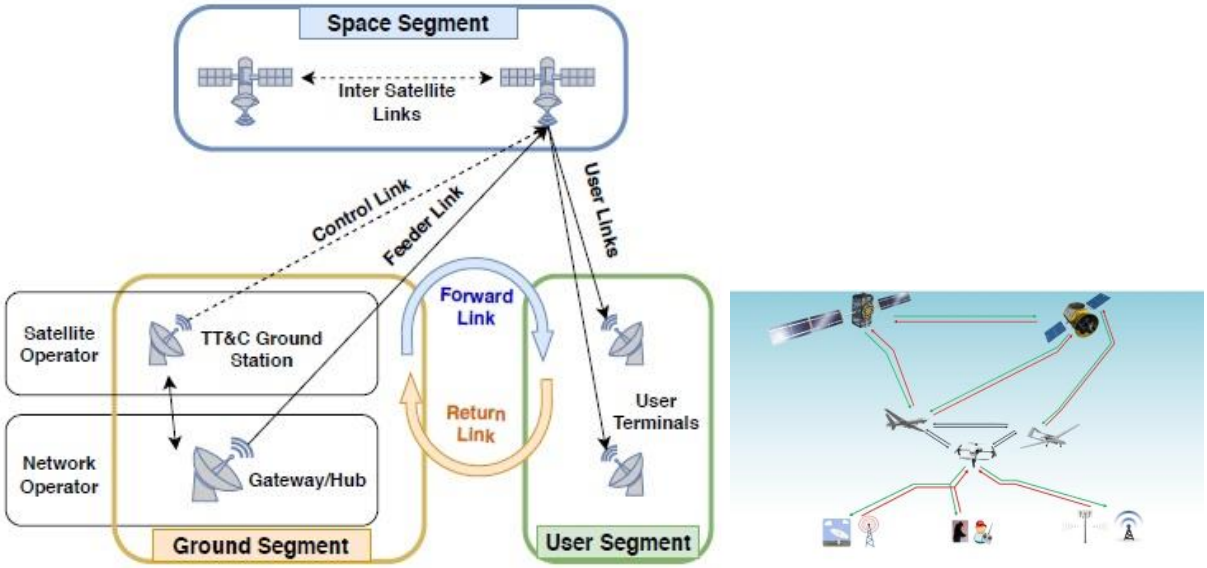




5.2 Fire Detection System 2020/2021

- This System Specification Document describes a distributed system for fire detection in rural and agriculture areas. On one satellite there will be inscha Allah also a X-Ray Astronomy sensor, which data is sent via a transmitter online to earth.
- System Configuration





5.3 LEO based AIS System

6 Whole investment activities of AS-COMSAT after predevelopment phase

6.1 Company vision

2021 Demonstration System for Exhibition

2021 Establishing company space at Istanbul

2022-2023 First Operational System

2024-2030 International Supplier

6.1 Specification Phase Aug 2020 - May 2021

AnalysisPhase_Specification_SupplierParts_pptx

6.2 Planning Aug 2020 - Jul 2023 (3 years)

Aug 2020 – Sep 2021	Team Foundation through weekly zoom meeting
2021	Development 2U Sat (COM(Transponder), Scientific (X-Ray Sensor) + 1U Sat (COM) + Ground Station
2022	
2023	

6.3 Initial Investment Planning for 1U Satellite (last update: Dec 2020)

Bismillah Last update: 19 Dec 2020

AS-COMSAT cubeSAT System (1 Satellite 10cmx10cmx10cm)

Material (from Suppliers) & Engineering Costs

Satellite Development Cost and Launch Cost

Working Package	Material Cost	Man Month	Qualification	Salary/MM	Personnel Cost per item	Total item cost
Camera	$50,000	6	Eng	$2,000	$12,000	$62,000
COM&Telemetry	$50,000	10	Eng	$2,000	$20,000	$70,000
Gyroscopes	$20,000	5	Eng	$2,000	$10,000	$30,000
Accelerometers	$20,000	5	Eng	$2,000	$10,000	$30,000
Reaction Wheel	$10,000	3	Eng	$2,000	$6,000	$16,000
			Eng	$2,000	$0	$0
Power System Solar panels, battery system	$15,000	4	Eng	$2,000	$8,000	$23,000
			Eng	$2,000	$0	$0
Board Control Computer	$10,000	8	Eng	$2,000	$16,000	$26,000
Antenna system	$10,000	3	Eng	$2,000	$6,000	$16,000
Integration	$10,000	3	Eng	$2,000	$6,000	$16,000
Test	$10,000	2	Eng	$2,000	$4,000	$14,000
Launch	$44,000	1	Eng	$2,000	$2,000	$46,000
Ground Station	$20,000	6	Eng	$2,000	$12,000	$32,000
	$269,000					
				Total Cost		**$381,000**

Material from suppliers
cube sat solar
deployable solar
ISIS cubesat scolare
crystal space P14 "Vasik"
EXA BA0 high energy density battery array
EXA Titan-1 350 whr high energy density...

Operational Cost per year

Working Package	Material Cost	Man Month	Qualification	Salary/MM	Personnel Cost per item	Total item cost
Maintenance	$40,000	12	Eng	$2,000	$24,000	$64,000
Ground Station	$20,000	36	Eng	$2,000	$72,000	$92,000
				Total Cost		**$156,000**

-> 381 k$ Investment

6.4 Investment Planning update for 2U + 1U Satellite + Ground Station System (last update: May 2021)

Goals of investment:

- Demonstration System (2U+1U+Ground Station)
- Team Building:
- Payloads: AIS Ship Communication System, Astronomical X-Ray Sensor

Engineering (ManPower Aug 2021-Jul 2023) 2 yrs x 5 persons x 12 k$	120 k$
Administration TEMO Aug 2020 – Jul 2021 (Analysis Phase)	25 k$
Administration TEMO (2 yrs Aug 2021 – Jul 2023) 2 x 25k$	50 k$
Material Cost Satellites (1U + 2U) + Ground Station	75 k$
Launching Cost (1U + 2U)	150 k$
Total	**$420,000**

6.5 Budget for 2022 (bureau in Istanbul from 2/2022)

rent Istanbul	Feb-Dec 2022	2.750 €
Salih Alfmeier		600 €
Reisekosten		3.600 €
Satellite material		40.000 €
Rozan Mustafa	Sep-Dec 2022	4.000 €
	Sum	**50.950 €**

6.6 Milestones 2022

Tue, 1.2.2022: Taking bureau in Istanbul

In AECENAR: COM unit (with HackRF)

In Istanbul: Integration of satellite (with local students)

In Istanbul: electronics lab, integration and testing lab, marketing / meeting space for customers

7 Investors

7.1 Data of Investors

Name	Amount	Date, Remarks

8 External Stakeholders and AS-COMSAT Staff

8.1 Stakeholders

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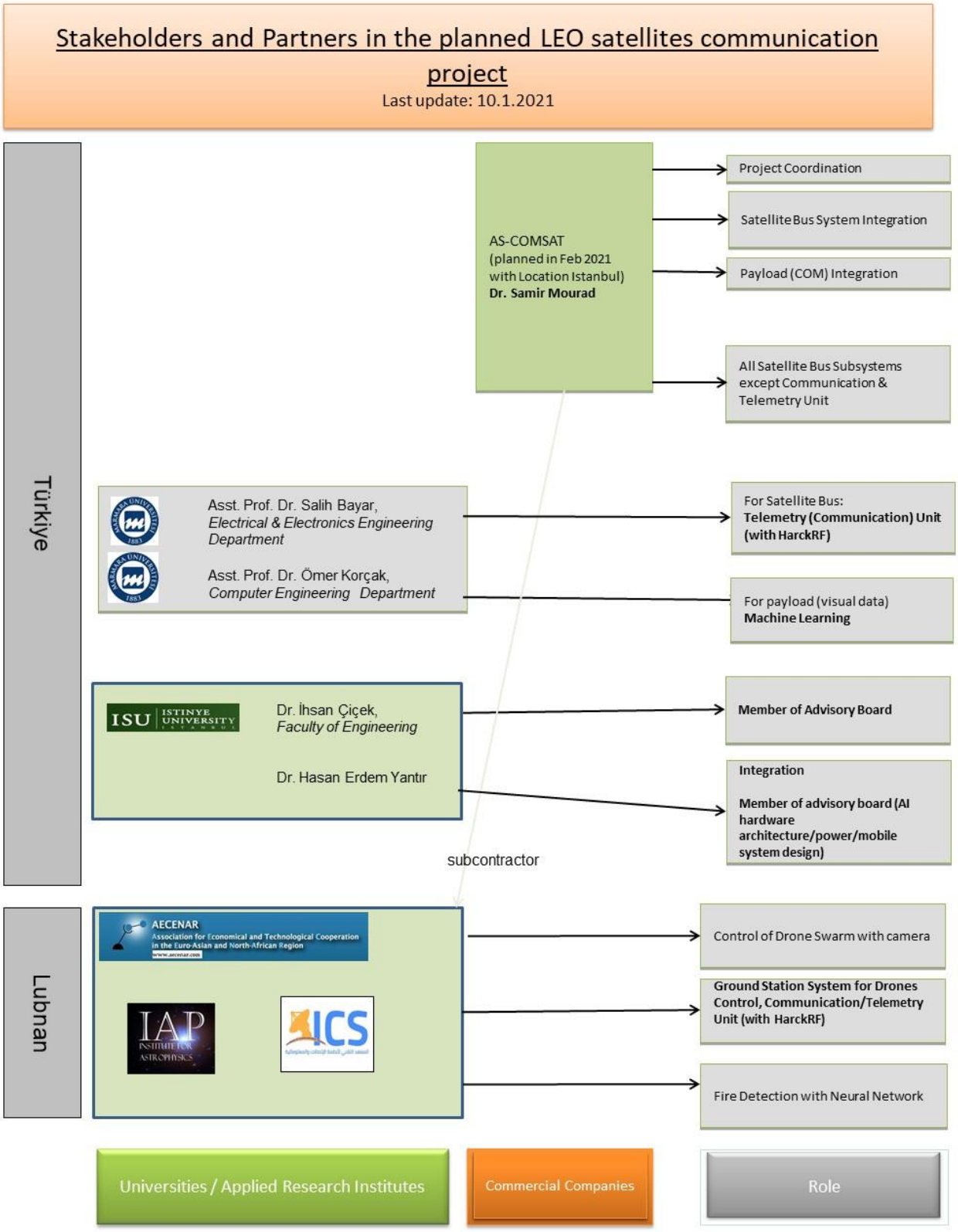
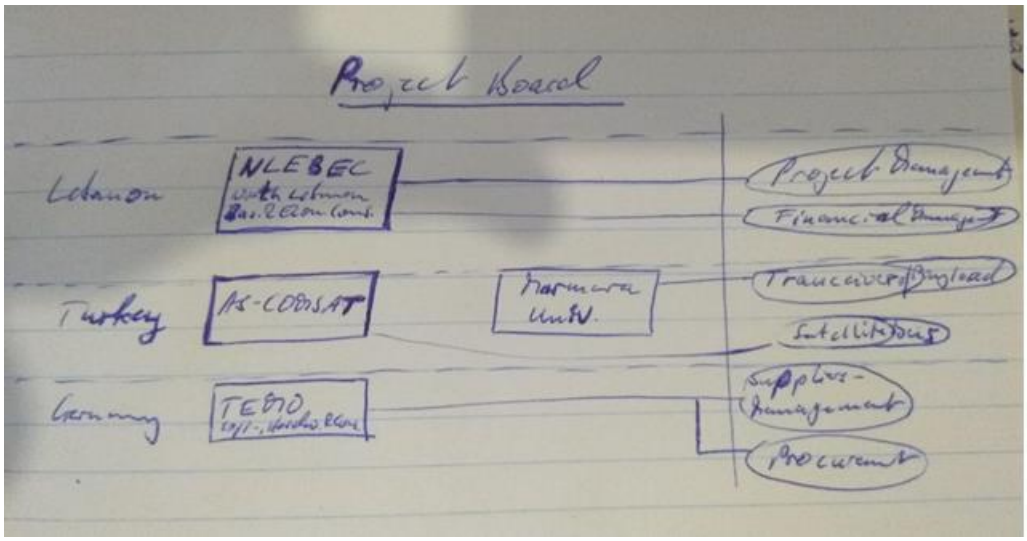


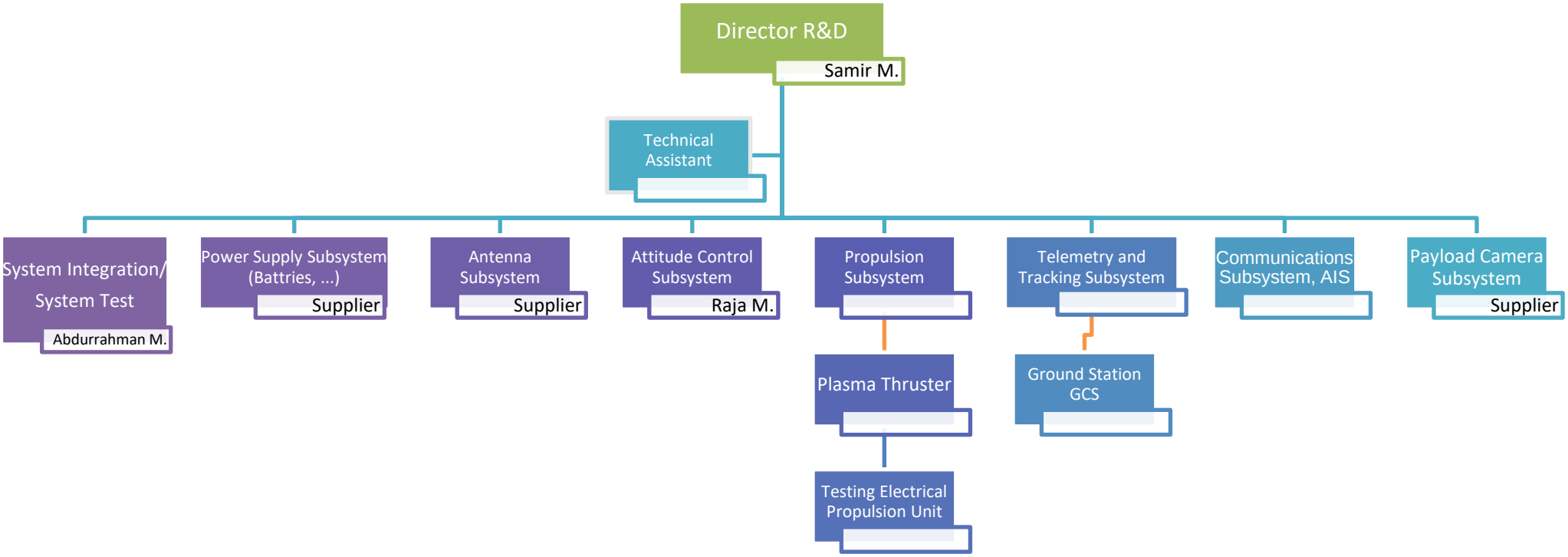


Launching supplier: to be defined

8.2 Salary list for beginners at AS-COMSAT

	$/hour	
Worker		
Specific worker (Welder)		
Student without Bachelor/Licence		
Bachelor Holder		
Master Holder		

8.3 Organizational chart (current and future)

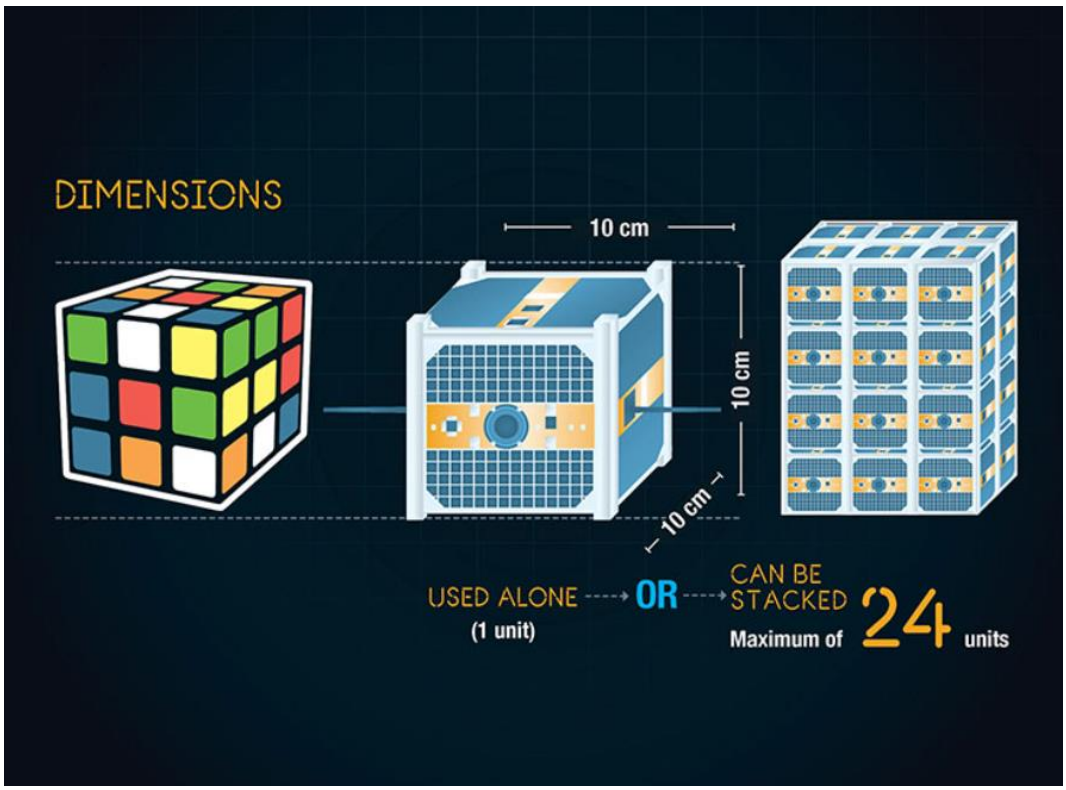


9 CubeSats Overview[1]

CubeSats are a class of research spacecraft called nanosatellites. CubeSats are built to standard dimensions (Units or "U") of 10 cm x 10 cm x 10 cm. They can be 1U, 2U, 3U, or 6U in size, and typically weigh less than 1.33 kg (3 lbs) per U. NASA's CubeSats are deployed from a Poly-Picosatellite Orbital Deployer, or P-POD.

9.1 What is a CubeSat?

A CubeSat is a square-shaped miniature satellite (10 cm x 10 cm x 10 cm—roughly the size of a Rubik's cube), weighing about 1 kg. A CubeSat can be used alone (1 unit) or in groups of multiple units (maximum 24 units).



A CubeSat is a type of very small satellite which is based on a standardized unit of mass and volume. The initial basic CubeSat unit measured 10x10x10 centimetre, conforming to specific interfaces for allowing a standardized containerized launch and had a maximum mass of 1 kilogram (the mass was later on increased to 1,33 kilogram).

It was quickly realized that such basic CubeSat units could be combined to form slightly larger spacecraft while mostly adhering to the same requirements and constraints. Multiples of the basic CubeSat unit were combined together to establish larger CubeSats. For example, a 1-Unit CubeSat

[1] https://www.nasa.gov/mission_pages/cubesats/overview

measures one single basic CubeSat unit as described above, while a 3-Unit CubeSat consists of 3 standard CubeSat units stacked together.

The CubeSat concept has become very popular, both in university groups, as well as for researchers, space agencies, governments, and companies. CubeSats offer a fast and affordable way for a wide array of stakeholders to be active in space and allow for a fast innovation cycle.

10 AS-COMSAT-1 System (Mechanics, Electronics & SW)

10.1 How communication is done

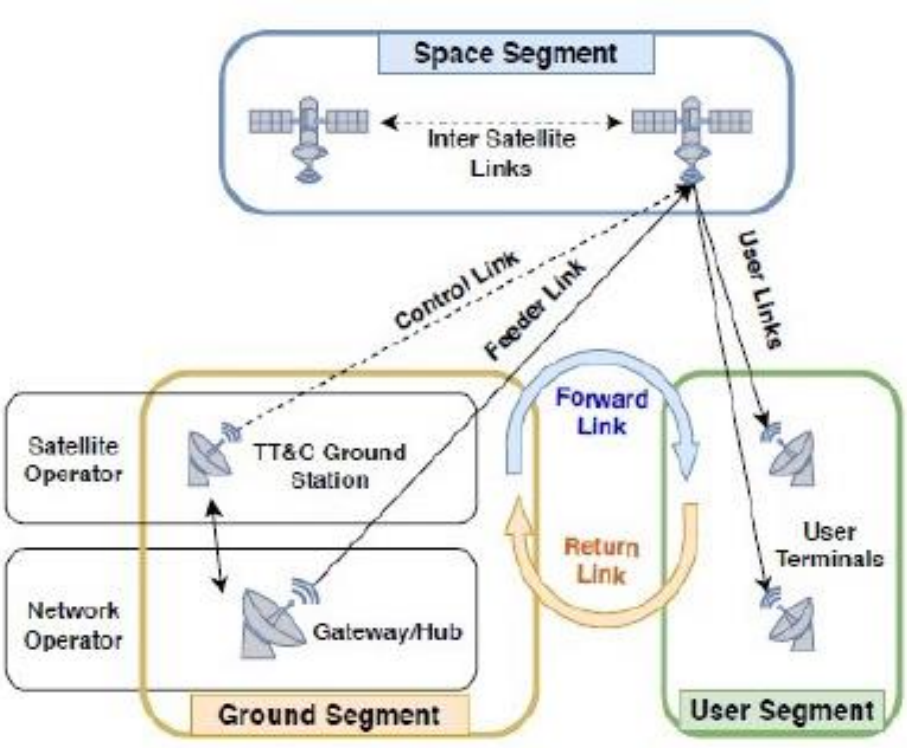


Figure 1: Communication and TT&C

10.2 Physical System Overview Example: the IRVINE-03 Education satellite

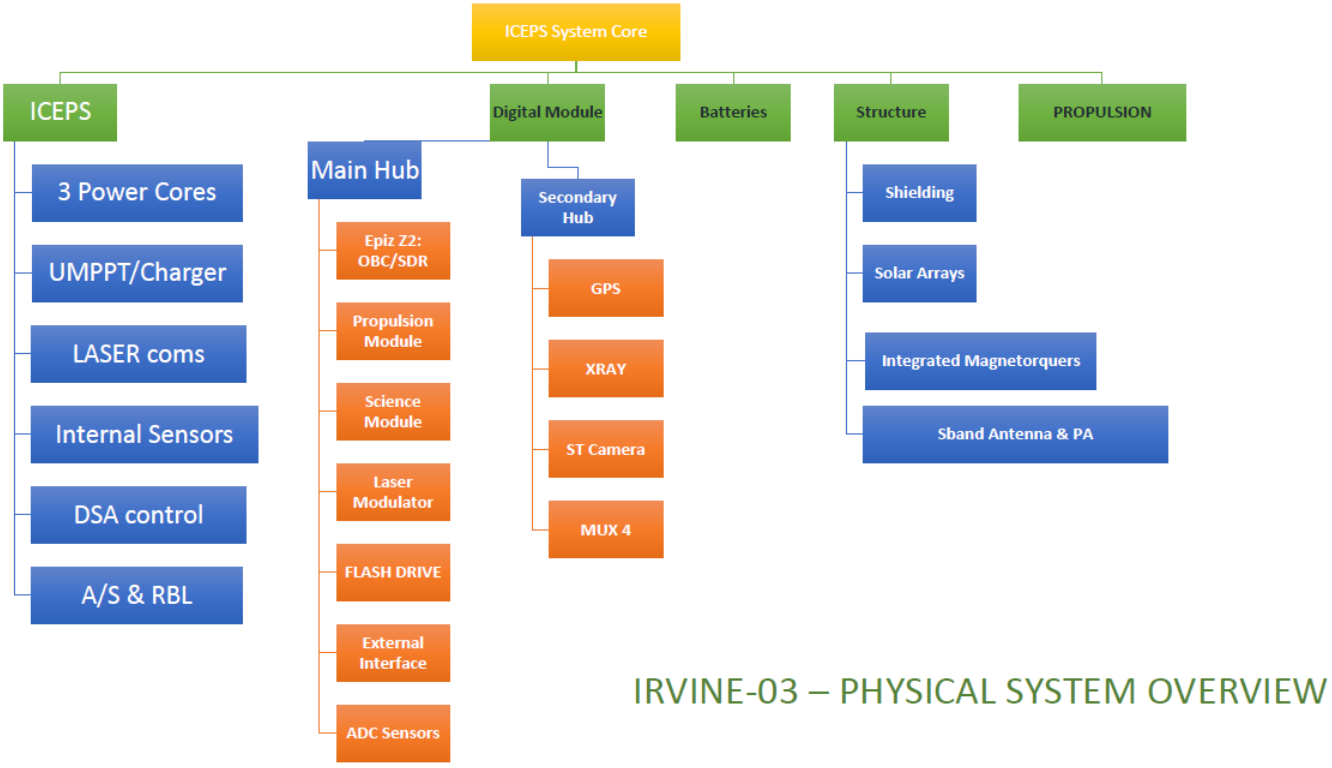


Figure 2: physical overview

- PA: (power amp) amplifies when transmitting.
- LNA: (low noise amp) amplifies when receiving.
- both sit between circuitry and antenna.
- for duplexed signal, passive duplexer shifts between the two on Rx/Tx

10.3 On-Board Computer (Raspberry Pi)

On this computer the NASA core flight system shall be implemented. System design: Jana Othman (Internship AECENAR July-Aug 2021).

10.3.1 OBC System

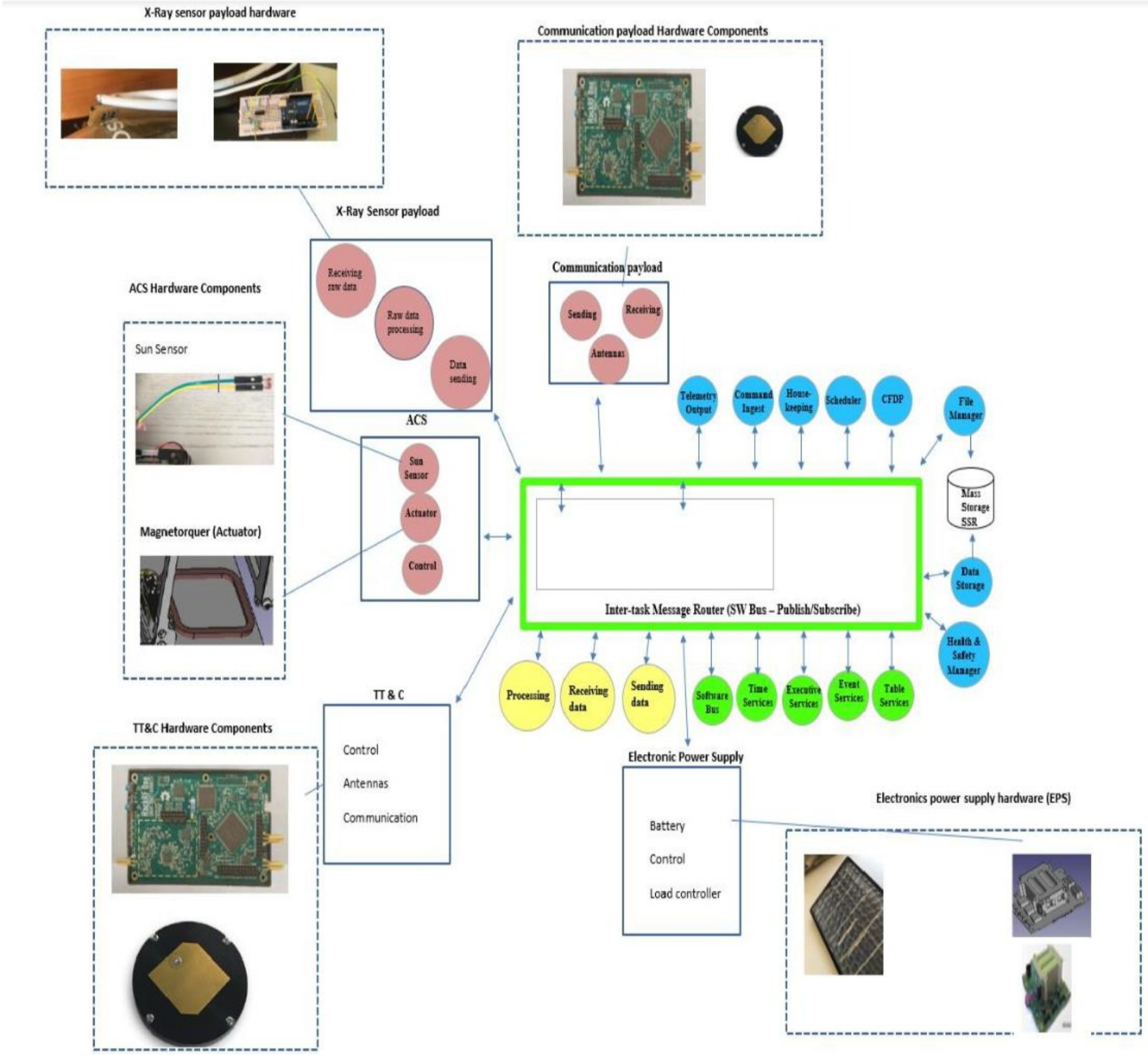


Figure 9: System Design

Legend:

: Components of a block

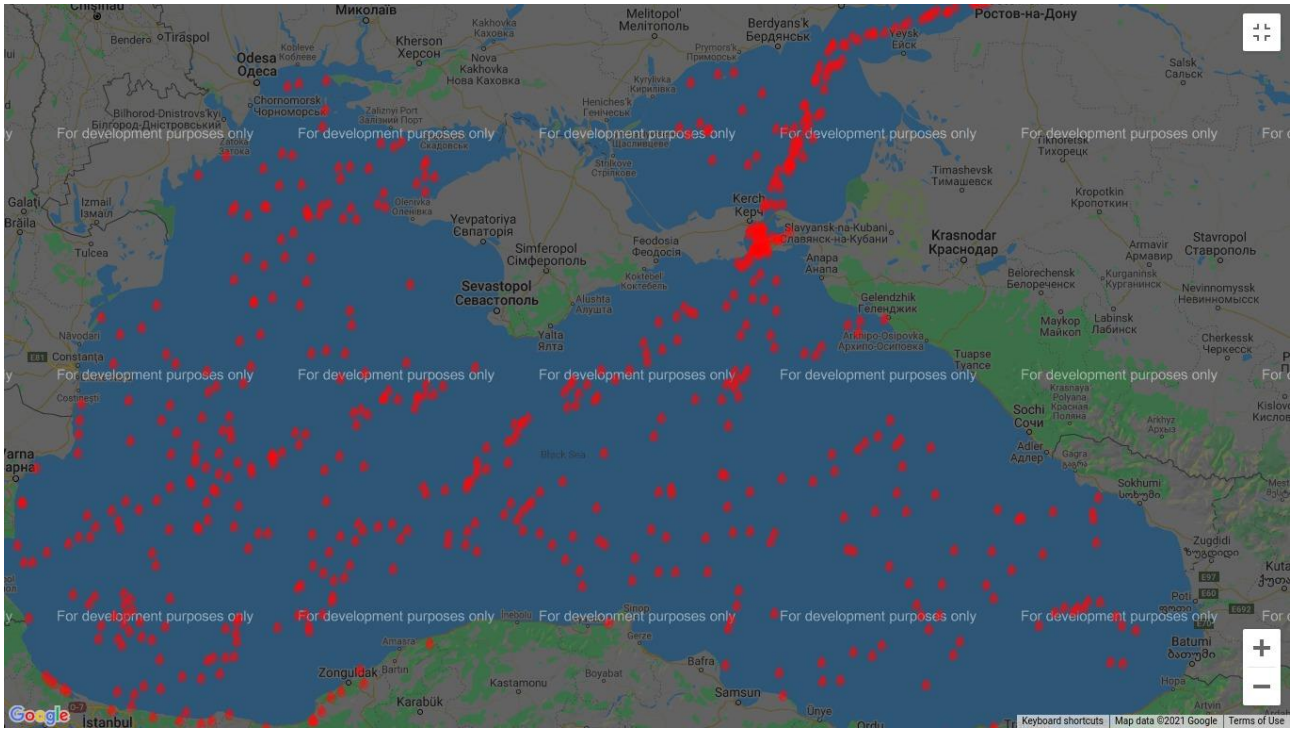
: CFS Configurable Applications

: cFE Core Services

: X-Ray Specific Apps

As payload also the AIS system shall be implemented (Rozan Mustafa as master thesis at Marmara Univ.)

10.3.2 AIS system on the OBC



Tasks:

- Satellite Footprint investigation to know how many visible satellites we need for AIS for black sea

Result: Requirements for satellite system:

- Orbit height: 500-600 km (over 600 km we get problems with AIS signals)
- Sun-synchronous orbit (restriction from launcher)
- Inclination: ?

Result from Rozan Oct 21:

>10 satellites needed

Height over earth: about 650 km

Period: 97.72 min.

Orbit ellipse axis a = 7027.748 km

Inclination: 100°-127°

(sun-synchronous orbit)

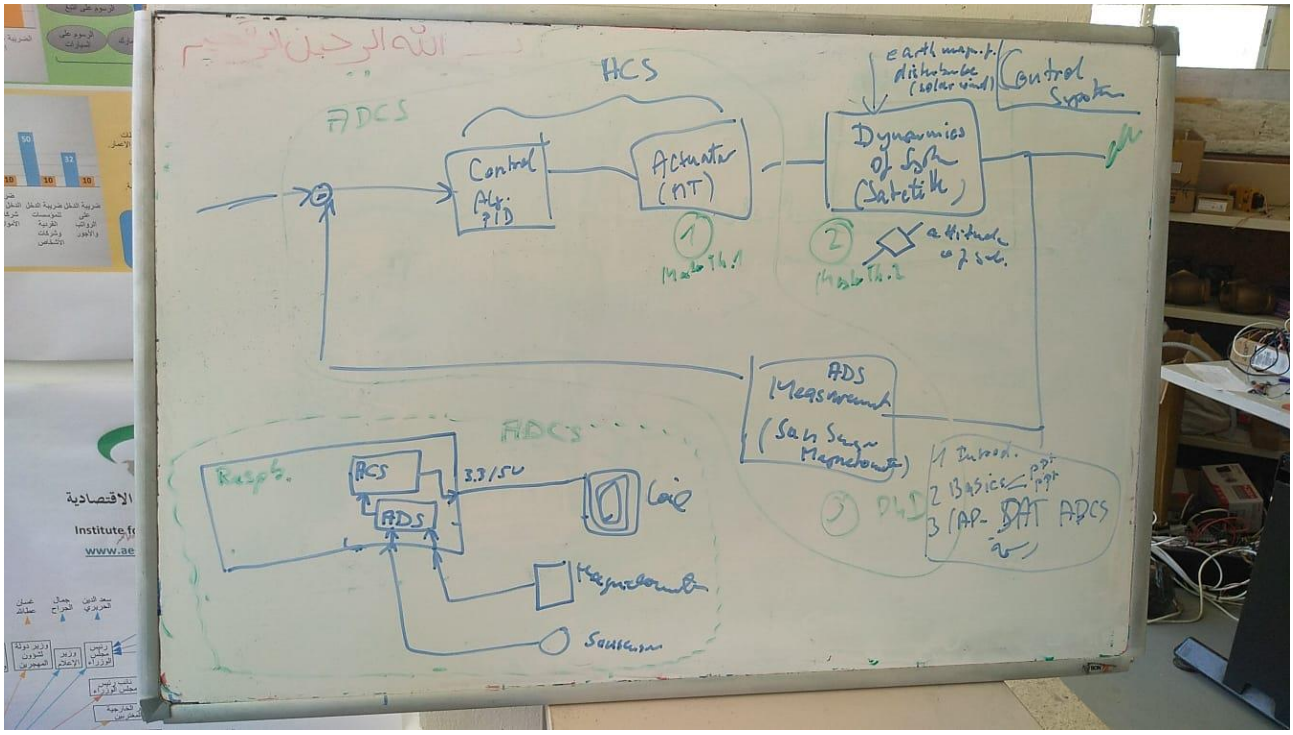
10.4 Attitude Control System (ACS) (Responsible: Raja)

Sensors: Sun sensor, IMU (see FCS of TEMOLeb-Mintad 2018 in TEMOLeb-Mintad Final Report[2])

[2] See [2]

Actuators: Magnetorquer

10.4.1 System Concept for Attitude Determination and Control System (ADS, ACS)



10.5 X-Ray Detector (Sensor) (Responsible: Yahya, Raja)

10.5.1 Silicon Detector Amplification Stages

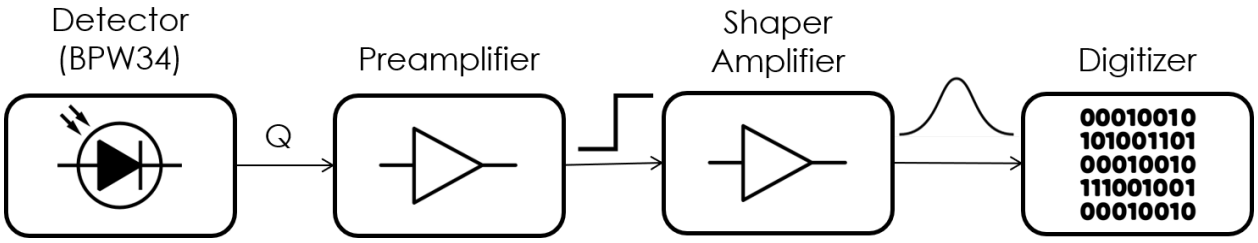
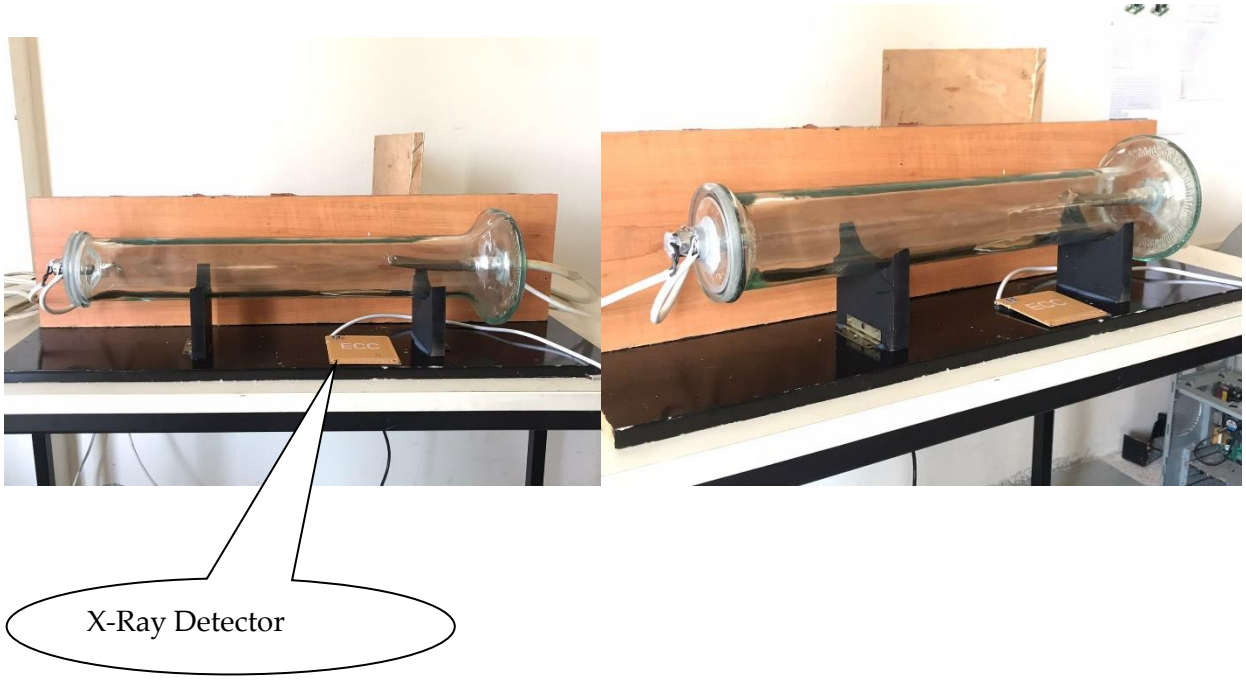
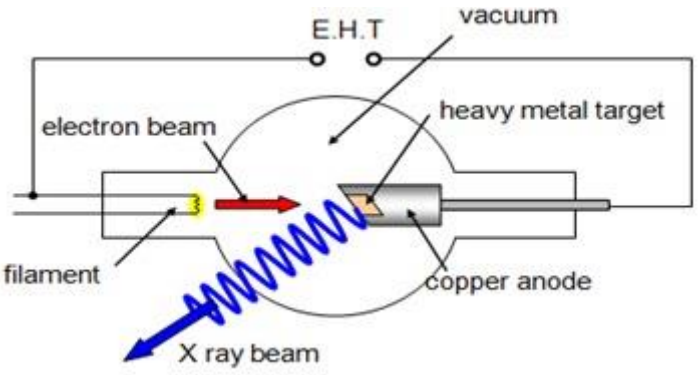


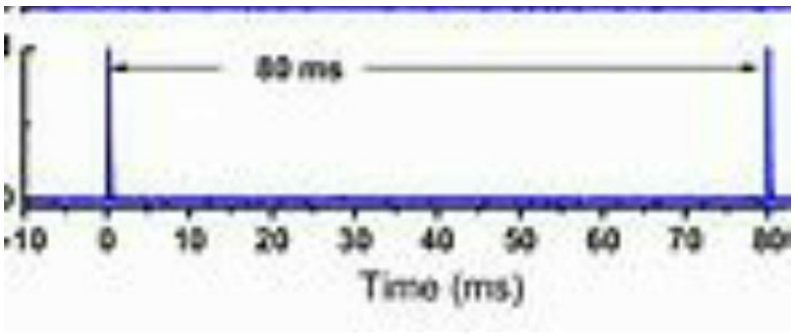
Figure 3. Silicon Detector Amplification Stages

10.5.2 Testing X-Ray Sensor with e-beam on cupper anode

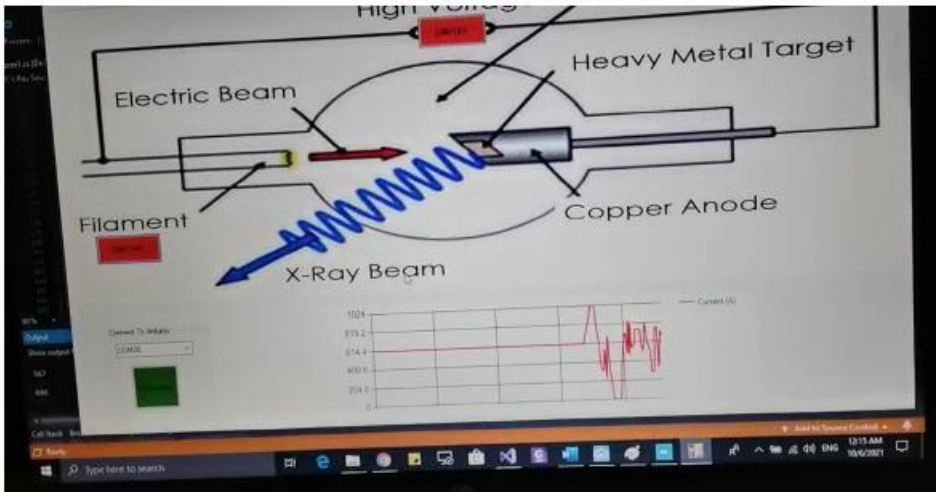


10.5.2.1 Specification of GUI:





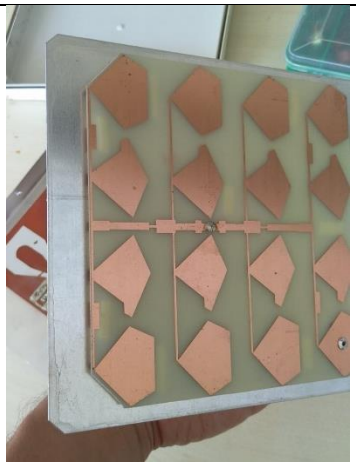
10.5.2.2 Implementation of GUI:



10.5.2.3 Realization of Field Control Unit:

Arduino board with RF module (wireless connection to GUI computer)

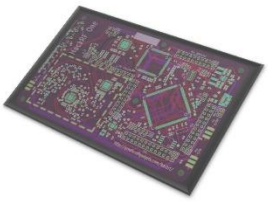
10.1 Telemetry, Tracking & Control (TT&C) on board

		
On-Board Computer (RaspberryPi)	HackRF SDR Card	Antenna

AECENAR
Association for Economical and Technological Cooperation in the Euro-Asian and North-African Region

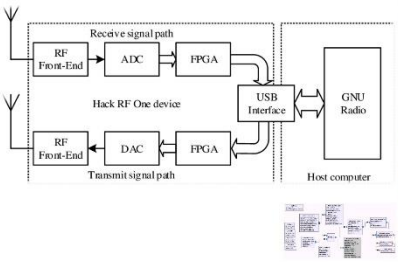
HackRF One

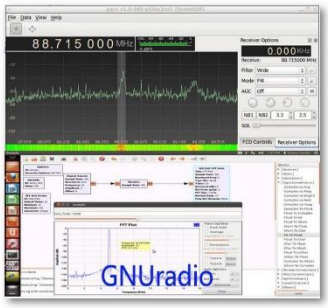
Software Defined Radio
1MHz to 6GHz

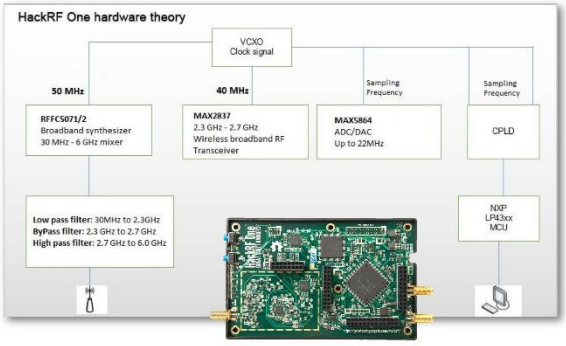


HackRF One from **Great Scott Gadgets** is a Software Defined Radio peripheral capable of transmission or reception of radio signals from 1 MHz to 6 GHz. Designed to enable test and development of modern and next generation radio technologies, **HackRF One** is an open source hardware platform that can be used as a USB peripheral or programmed for stand-alone operation.

Specifications:
- 1 MHz to 6 GHz operating frequency
- Half-duplex transceiver
- Up to 20 million samples per second
- 8-bit quadrature samples (8-bit I and 8-bit Q)
- Compatible with GNU Radio, SDR#, and more
- Software-configurable RX and TX gain and baseband filter
- Software-controlled antenna port power (50 mA at 3.3 V)
- SMA female antenna connector
- SMA female clock input and output for synchronization
- Convenient buttons for programming
- Internal pin headers for expansion
- Hi-Speed USB 2.0
- USB-powered
- Open source hardware







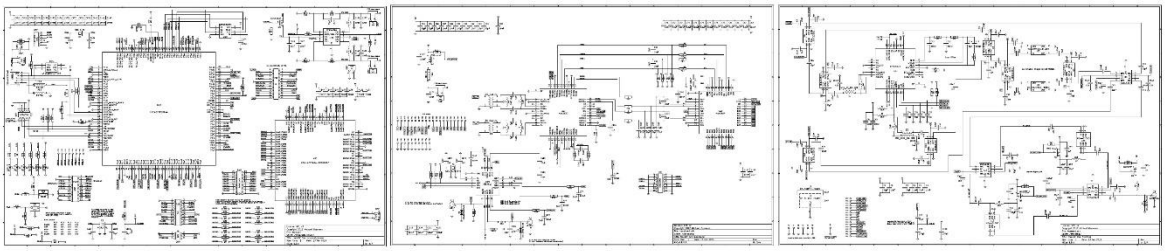
Buttons:
The **RESET** button resets the microcontroller. This is a reboot that should result in a USB re-enumeration.
The **DFU** button invokes a USB DFU bootloader located in the microcontroller's ROM. This bootloader makes it possible to unbrick a HackRF One with damaged firmware because the ROM cannot be overwritten.

To invoke DFU mode: Press and hold the DFU button. While holding the DFU button, reset the HackRF One either by pressing and releasing the RESET button or by powering on the HackRF One. Release the DFU button.
The DFU button only invokes the bootloader during reset. This means that it can be used for other functions by custom firmware.

Parameters:
- Frequency band: 1MHz-6Ghz
- Data bandwidth: 20MHz
- Sampling accuracy (ADC/DAC) : 8BIT
- Sampling speed (ADC/DAC): 20Mbps
- Maximum transmitting power: 10dbm
- 64QAM transmitting EVM: 1.5%
- Complex sampling bandwidth: 20Mhz

Hardware:
- Mixer RFFC5072: 80MHz-4200MHz
- Wireless bandwidth RF transceiver MAX2837: 2.3Ghz-2.7Ghz
- Processor LPC4330: Main frequency 204MHz
- Amplifier MGA-81563: 0.1-6Ghz, 3V, 14dbm

- The RF switch determines whether to amplify via a 14db amplifier
- The signal is filtered by high pass or loss pass filter
- Signal RFFC5072 chip mixing to 2.6GHz fixed medium frequency
- The firmware supports variable intermediate frequency options: range 2.15 GHz to 2.75 GHz
- Signal into the MAX2837 chip mixing to the baseband, output differential IQ signal (MAX2837 chip can limit the bandwidth of the signal)
- The MAX5864 chip digitizes the baseband signal and sends it to CPLD
- The LPC4320/4330 processor sends the sampled data to computer via USB
- RFFC5072 and MAX2837 are protected in a shield to prevent interference from the outside world or other chips on the board, and to prevent static electricity form penetrating some chips



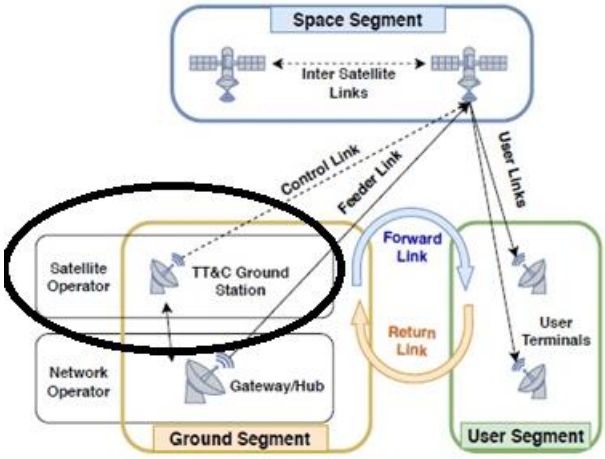
Notes:
- Due to the HackRF clock is passive OC, factory board accuracy usually in 20PPM, 1MHZ frequency offset at about 20HZ, 1GHZ is 20KHZ changes, usually frequency will affect the change with the environment, usually this effect is not high on the requirements of the occasion to have any effect, such as what is the impact of wireless receiving and not after all, HACKRF has 20MHZ bandwidth, but in wireless transmission on different meanings, such as the GPS system, the frequency of 1575.42MHZ if PPM is 20 then the frequency offset 1575.42MHZ× (1575.42*20=0.0315084MHZ) =1575.42 + 3, so it can not satisfy the applications of GPS, but the PPM 2 accuracy of 0.003MHZ is obviously meet the requirements. TCXO clock module PPM0.1 uses the high accuracy TCXO design, the DIP packing accuracy in 0.1-0.5ppm.
- Some connectors that appear to be SMA are actually RP-SMA. If you connect an RP-SMA antenna to HackRF One, it will seem to connect snugly but won't function at all because neither the male nor female side has a center pin. RP-SMA connectors are most common on 2.4 GHz antennas and are popular on WI-FI equipment.
- Board may Need to flash the firmware from before use the following link: https://github.com/sharebrained/portapack-hackrf/releases

References:
https://greatscottgadgets.com/hackrf/one/, https://greatscottgadgets.com/sdr/, https://github.com/sharebrained/portapack-hackrf, https://github.com/mossmann/hackrf , https://github.com/mossmann/hackrf/wiki/HackRF-One,

ICS
المركز التقني للإتصالات والمعلوماتية

10.2 Telemetry, Tracking & Control (TT&C) Ground Station

10.2.1 Requirements (A DESCRIPTION OF A STANDARD SMALL SATELLITE GROUNDSTATION FOR USE BY WMO MEMBERS [4])



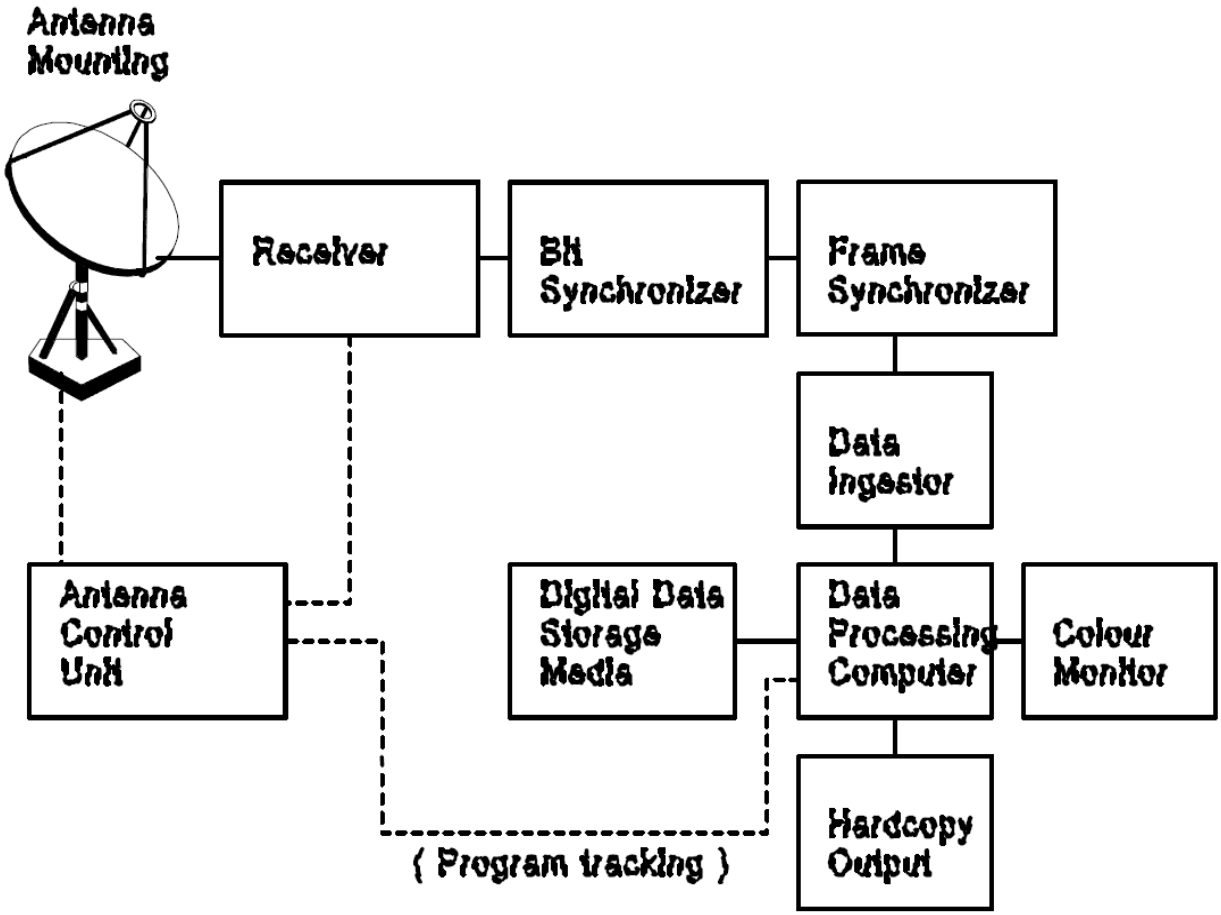


Fig.1 Block Diagram of a small satellite ground station

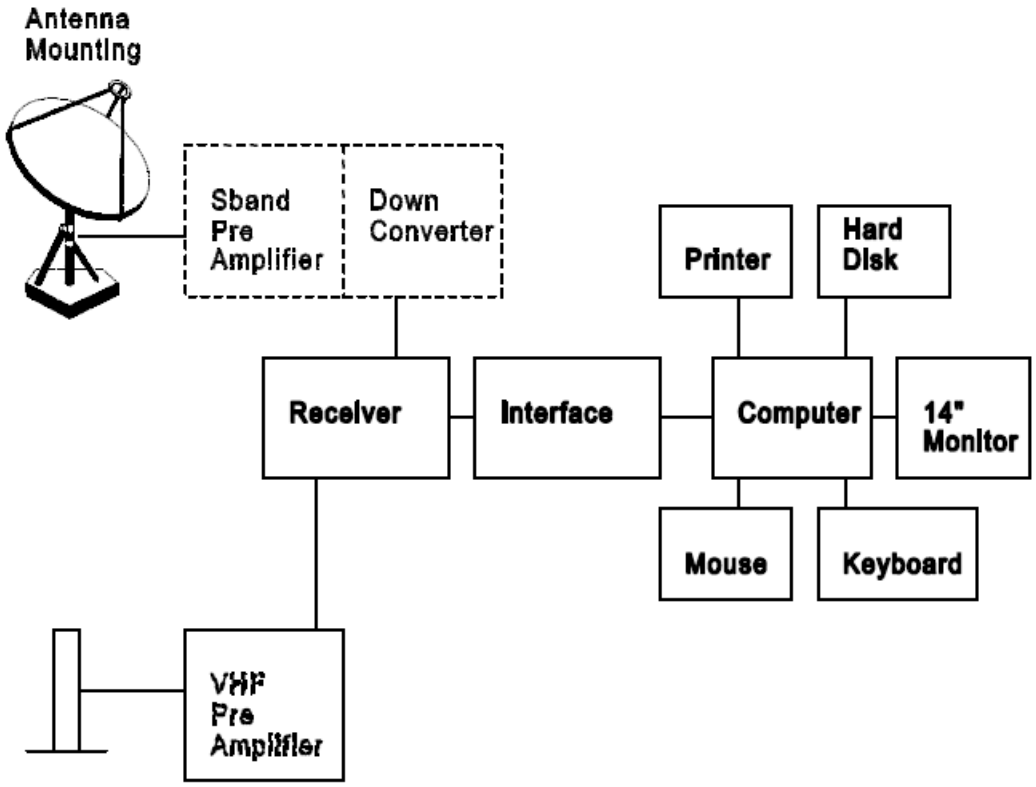


Fig.2 APT/WEFAX Receiving and Processing Station

بسم الله الرحمن الرحيم

Anadolu-Sham COMSAT

07.10.21

Task (Bachelor Thesis/Student Project)

Development of a Ground Station for a system of 4 LEO satellites (AS-COMSAT_1)

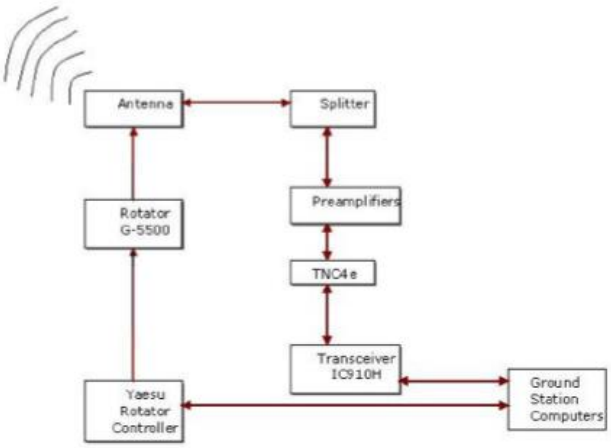
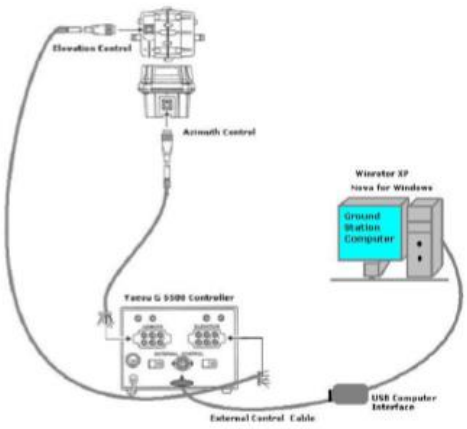
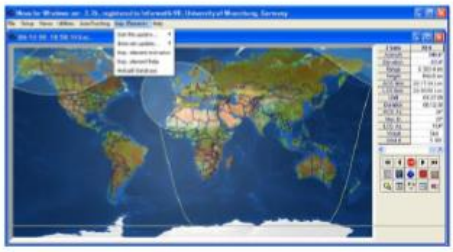


Figure 1.4: Block Diagram of the Ground Station.



Rotor-Controller-Computer Interfacing.



Graphical User Interface

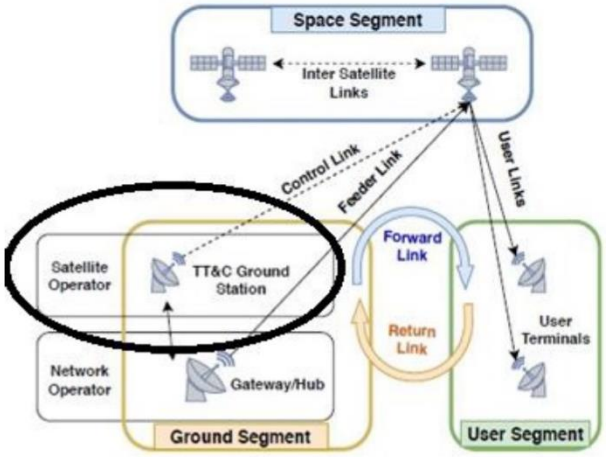
11 Hardware in the loop (HIL) Test System

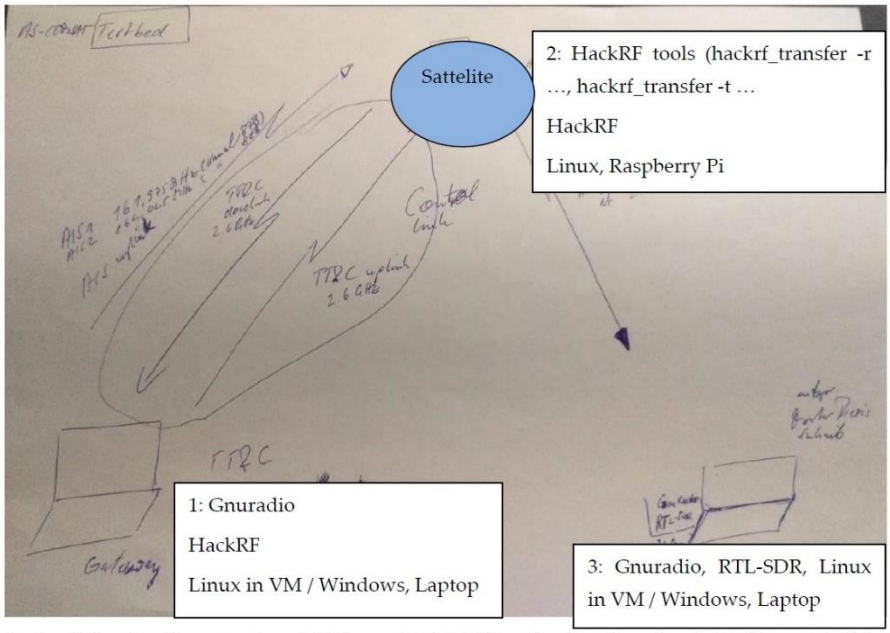
Space Segment:

- Raspberry (Linux, Gnuradio, NASA coreFlightSystem)
- ACS (magnetorquer, IMU from IAP-SAT))
- HackRF
- Antenna
- Structure

Ground Segment:

- Laptop (Windows or Linux, GnuRadio/PothosSDR)
- Antenna
- HackRF





Payload: Sending from 1 to 2 an AIS file on 161.975 MHz – Sending from 2 to 3 this file on 2.6 GHz

Telemetry, Tracking & Control (TT&C): Sending from 1 to 2 a control command file on 2.6 GHz, sending from 2 to 1 a file with sensor information on 2.6 GHz

12 Launch issues

From

12.1 Offer from Russian Company (Launch with Soyuz) from May 2021

www.gklaunch.ru, info@gklaunch.ru

2 U, 3 kg: 110,000$

Dear Samir! Thank you for your launch quote request. We have prepared a ROM price proposal based on your satellite's chara□eristics and sele□ed a suitable mission.

Mission:

> Cluster launch
> Launch period: 2 quarter of 2022
> Orbit: SSO, LTAN 11:00
> Baikonur Cosmodrome
> Primary payload: contracted
> Secondary payload: available

Launch price:

for 3kg satellite is 110000$

The price includes:

1. Program management and program documents;
2. Support of Customer personnel visits;
3. Administrative support to the Customer personnel at GK facilities in accordance with the terms and conditions to be defined in the contract;
4. Program reviews and meetings as may be necessary;
5. Interface Control Document with the results of analyses and reports as may be necessary;
6. Hardware (adapter and separation system, umbilical connector, harness for testing), personnel and equipment for fit-check to be performed at the NPOL facility (SC dummy for testing to be provided by Customer);

7. Hardware (adapter and separation system, umbilical connector, harness), personnel and equipment for integration of the flight SC with the launcher;
8. Hardware, ground support equipment (Space Head Module (SHM), Fregat upper stage, launch vehicle) and personnel for processing of the SHM with SC and execution of launch;
9. Customs clearance of SC/GSE on entry into Russia, customs clearance of GSE on exit from Russia;

10. Tran□ortation of satellite and GSE from the entry/exit port to payload preparation facility and back of GSE, including their customs clearance;
11. Performance of launch campaign and provision of:
Work place in AITB;
Administrative and storage premises;
Power supply;
Provision of logistics to Customer's personnel whilst at the launch site (payment for the services to be made by Customer);
Communications services (international telephone calls to be paid for in accordance with the terms and conditions to be defined in the contra□).
Launch of deployer with CubeSat(s) into the required orbit;
12. Provision to Customer of LV telemetry data confirming the SC separation and initial orbit parameters;
13. Post-launch services;
14. Photographic and video documentation;
15. Linguistic support;
16. Procurement of third party liability insurance for the damage due to the launch activities and support in obtaining the satellite insurance;
17. Launch observation.
You can add insurance of the satellite ground and space related risks and insurance of
the launch service. To do so, call us or write a response letter.
This is a ROM launch price proposal to be finalized after we receive all the documents. Some mission parameters may change.

Standard Milestone payment plan:

	Milestone	Payment, USD (%)	Preliminary Date of milestone completion and submission of invoice
1	Manifesting of Payload on a Launch Mission	15%	Manifesting of Payload
2	IRD review	15%	Completion of IRD review
3	ICD approval	25%	Approval of ICD
4	Ground Tests	20%	Completion of ground tests
5	Start of Launch Campaign	15%	Upon Payload arrival at Launch Site
6	Successful launch	10%	L+2 weeks

GK Launch Services is an operator of Soyuz-2 commercial launches from the Russian spaceports.

ROSCOSMOS

GLAVKOSMOS

KOSMOTRAS

GK LAUNCH SERVICES

GK Launch Services subcontractors' team

PROGRESS ROCKET &SPACE CENTRE	NPO LAVOCHKIN	FSUE «TSENKI»
Developer and manufacturer of Soyuz-2 LV	Developer and manufacturer of Fregat upper stage	Provider of ground infrastructure facilities at Russian spaceports for launches

Soyuz-2 launch sites location

The proposal is valid for 20 work days.

GK Team
Contact us at:
+7 (495) 150-44-71
sales@gklaunch.ru

SOYUZ-2 NOT JUST A ROCKET
NEED A RIDE? › GK LAUNCH SERVICES

12.2 Companies launch satellite

12.2.1 GK laucnh (Russian)[3]

GK Launch Services is a company established by Glavkosmos (a subsidiary of ROSCOSMOS State Space Corporation) and International Space Company Kosmotras. GK Launch Services is an operator of Soyuz-2 commercial launches from the Russian spaceports.

The key targets this joint venture aims at include advancing of commercial launch services, promotion of Russian launch vehicles on the world market, and strengthening the positions of Russia as the most competitive launch service provider.

A solid competence of the two partners facilitates achieving these ambitious goals. Glavkosmos has been participating in global international space projects over 30 years and has already had experience in provision of launch services with Soyuz-2 rocket. Kosmotras has lofted over 100 payloads within 22 commercial launches.

12.2.2 Swarm company (U.S)[4]

Swarm Technologies, Inc. is a private company building a low Earth orbit satellite constellation for communications with Internet Of Things (IOT) devices using a Store and forward design. An early investor was Craft Ventures. On July 16, 2021, Swarm entered into an agreement to become a direct wholly-owned subsidiary of SpaceX.[2]

They have an Federal Communications Commission (FCC) licence for low bandwidth communications satellites in low Earth orbit.[3]

In 2018 Swarm became the first ever company found to have deployed satellites without regulatory approval after an FCC investigation into the startup's launch on an Indian PSLV rocket of its first four picosatellites in January that year.[4]

By December 2020, Swarm had launched 9 test satellites and 36 of a planned 150 low Earth orbit satellites to provide communication with IOT devices.[5]

In February 2021 Swarm announced that its commercial services were now live using 72 commercial satellites providing its global low cost data to customers.[6]

The Swarm Tile is its dedicated satellite two-way data modem designed to be low energy and embedded on the PCB of third party products. Other products include a data plan and development kit.[7]

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http://gklaunch.ru/en/ [3]

https://en.wikipedia.org/wiki/Swarm_Technologies[4]

12.2.3 Exolaunch company (Germany)[5]

The protocol of launching is:

1) LAUNCH PLANNING

Every mission is unique. We listen to you and offer solutions that will enable the successful launch of your satellite. With precision, knowledge and expertise, we make the complex work of your specific campaign a simple and affordable experience. No stress.

2) MISSION MANAGEMENT

Next, we produce your event. We provide technical management of the satellite adaptation to a launch vehicle, interface control document development, mission analysis delivery, and launch schedule coordination.

3) SEPARATION SYSTEMS

EXOpod deployers for cubesats and CarboNIX, the shock-free separation systems for microsatellites, are designed and produced by Exolaunch to support your mission needs. Later, we adapt the deployment systems to the launch vehicle to safely deliver your satellite into its target orbit.

4) DEPLOYMENT SEQUENCER

EXObox is essential for smallsat cluster launches. It is a unique, highly reliable and modular deployment sequencer to manage the deployment of up to 50 satellites with just one EXObox unit. It will precisely and safely separate small satellites into their target orbits.

5) LICENSING

In this phase, we handle the complex legal and regulatory support documents that are required for launch. Your desk is now clean!

6) ENVIRONMENTAL TESTING

Our fully-fledged environmental testing services are tailored to the requirements of any launch vehicle, ensuring your satellite has made the grade. All of the tests are performed in Berlin, and yEnvironmental tests profiles and types:

a. Vibration and shock testing

We provide a full range of mechanical testing to cover the qualification, proto-flight or acceptance requirements of all launch vehicles.

b. Thermal and vacuum testing

[5] https://exolaunch.com/

Thermal cycling and thermal vacuum testing is available to meet your mission requirements. Whether testing survivability limits or simply performing a vacuum bake-out, we can perform the tests that fit your needs.

c. Qualifation and acceptance test

Qualification of your design based on the composed mechanical loads in order to meet the requirements of most common launch vehicles. Tailored acceptance testing profiles of your flight models to the launch vehicle of your choice, ensuring the function of your spacecraft while increasing confidence in its reliability.

d. Test profiles design

We offer support to develop individual specifications for mission tailored test profiles with optimized loads and durations. Inclusive our acceptance guarantee of the test profiles by the launch authority.

e. Adapters & additional hardware

We offer TestPods and other test fixtures with the test interfaces identical to the launch vehicle interfaces, ensuring the validity of all test results. ou are offered our cleanroom for satellite checkouts.

7) SHIPMENT

Our expertise in global logistics and experience with customs clearance allows us to process worldwide shipping of payloads and equipment in a safe, convenient and timely fashion. We will ensure your satellite reaches the launch site safely and without hassle.

8) INTEGRATION SERVICES

When your satellite meets the launch vehicle. We will seamlessly integrate your satellite with the support hardware onto its launch vehicle.

9) LAUNCH

The launch vehicle has left Earth. Shortly afterwards, we receive a positive signal that your satellite is in orbit and is ready to start changing the world.

12.2.4 Gunter's space page[6]

The four **SpaceBEE**, formerly known as **BEE**s (**Basic Electronic Elements**), picosatellites, built to the 0.25U CubeSat form factor are to demonstrate two-way satellite communications and data relay for Swarm Technologies Inc.

The mission is to test the world's smallest two-way communications satellites to serve as a cost-effective low-data rate Internet of Things (IoT) network connectivity solution for remote and

[6] https://space.skyrocket.de/doc_sdat/spacebee.htm

mobile sensors. The initial experimental space deployment is comprised of four satellites, each with a 1/4U form factor employing radar signature enhancement technology, which enables them to be passively tracked, and using VHF band frequencies for communications. There will also be an experimental deployment of ground stations for communications with the space units.

The mission is to demonstrate the capabilities of these picosatellites for serving low data rate communication relays for remote sensors and data collectors. Experimental operations is scheduled to begin upon launch for a period of at least 6 months and up to 2 years

The tiny satellites have very small radar cross section, which might complicate the tracking. Therefore they featured a GPS device in each satellite that would broadcast its position on request. Also the four smallest faces of the satellites are covered with an experimental passive radar reflector developed by the U.S. Navy's Space and Naval Warfare Systems Command, which according to the FCC application would increase the satellites radar profile by a factor of 10.

The FCC dismissed Swarm's application. Nevertheless, the satellites have been launched, apparently without a valid licence, in January 2018 on an Indian PSLV-XL rocket under the name **SpaceBEE**. The ownership of the SpaceBEEs remained obscure, until in an IEEE Spectrum article the identity of the SpaceBEEs with Swarm's BEE satellites was revealed.

A follow-on mission, SpaceBEE 5 to 8, with larger 1U CubeSats was also not granted a licence after this. Later the licesnce was granted. SpaceBEE 1 to 4 were also granted an operation licence.

The operational 2nd generation SpaceBEE satellites reverted back to the 0.25U form factor.

12.2.5 Antrix corporation (India)[7]

I contacted this company and the emails are below:

12.2.5.1 RE: FW: question for procedure to launch a satellite

November 25, 2021 7:44 am 28 KB
From:

Ganesh Mohan <ganesh_mohan@antrix.co.in>
To:

siham.aisha@temo-group.com

Hi Siham,

Could you please elaborate on what is it that you're looking for in administrative and legal procedures?

I presume all the permits, authorisations and notices of non-opposition including frequency filing / other regulatory mandates would be already done by you, during the course of the project.

[7] https://www.antrix.co.in/

We will support in any administrative matters during the import and re-export of the payload and the auxiliaries, including transportation, testing facilities, accommodation of personnel etc during the launch base. Once the satellite is separated in a low earth orbit, the control gets passed over to you. All the other aspects like Indemnity, Insurances etc would be covered in the launch contract and we can discuss over it during the course of execution of the contract.

Thanks

Ganesh

From: Siham [mailto:siham.aisha@temo-group.com]
Sent: 22 November 2021 15:53
To: Ganesh Mohan
Subject: Re: FW: question for procedure to launch a satellite

Hello,
Thank you for your response.

We need know what is the administrative and legal procedure in details, I mean if we want to keep some legal files we wish to inform us.

I prefer an email contact to be clearly.
our location is in Lebanon - Tripoli - Ras masqa, name of my organization is North Alternative Power departement TemoGroup

Regards

On November 22, 2021 at 11:57:24 am +02:00, Ganesh Mohan <ganesh_mohan@antrix.co.in> wrote:

Hi Siham,

Thanks for your interest in Antrix.

The procedure is that

1. there will be a launch services agreement that we will have to execute, wherein the said satellite will be accommodated as a ride share with one of the upcoming PSLV / SSLV missions.

2. There will be an Interface control document, where all the details of the testing, Dynamic studies, sequencing, power supply etc would be addressed and cleared.

3. The launch would happen from Sriharikotta, where the necessary testing / operations / safety procedures would be happening.

With respect to the pricing, it will vary. May I know where are you based at and the company that you're working for? We can probably discuss it over a call.

Thanks

Ganesh Mohan

Manager, Antrix Corporation

From: Siham [mailto:siham.aisha@temo-group.com]
Sent: 16 November 2021 15:39
To: sonali@antrix.co.in
Subject: question for procedure to launch a satellite

Hello,

I want to launch a satellite, Could I have a quote of price and what is the procedure to launch it?

1- the time frame it's about in the middle of 2022

2- launch to the same inclination, I mean in the same orbit and the inclination is 100 degre - 127 degre

3- our spacecraft don't have propulsion

4- size of our spacecraft is : 10X10X20 cm 2U for 2 satellites

5- mass is: 3Kg

6- the purpose: small pilot system for communication satellite.

7- altitude: 650 km

8- elliptic semimajor axis a = 7027.748 km

9- orbit heigh: 500- 600 km

Regards,

Siham

12.2.5.2 Procedure to launch a satellite in India[89]

Norms, Guidelines and Procedures for Satellite Communications Announced

The Government has approved a policy that envisages allocation of INSAT system capacity for non-governmental users, registration of Indian satellite systems by private Indian companies and limited use of foreign satellites in special circumstances. The Department of Space (DOS) will be the administrative ministry in all matters related to satellite systems in India.

As per the policy, the Indian National Satellite System (INSAT) capacity will be made available to non-government (private) Indian Service Providers on a commercial basis subject to availability after meeting the government needs. The DOS will allocate INSAT capacity for private users. DOS may also build capacity in INSAT system for private users on request on commercial basis.

Private Indian companies with a foreign equity less than 74 percent are now allowed to establish Indian Satellite Systems. These companies can submit their applications for registering their satellite systems to the Committee for Authorising the establishment and operation of Indian Satellite Systems (CAISS). The office of CAISS is set up at the SatCom Programs Office at ISRO Headquarters, Antariksh Bhavan, New BEL Road, Bangalore- 560 094. The authorisation to operate the Satellite System and the Orbit spectrum notification/registration will be done by CAISS. However, operating licenses for services to be provided by the Indian Satellite Systems will be

[8] https://www.isro.gov.in/update/08-may-2000/norms-guidelines-and-procedures-satellite-communications-announced

[9] https://www.isro.gov.in/contact-us-0

issued only by the concerned administrative departments like Department of Telecommunication for telecom services and Ministry of Information and Broadcasting for TV/Radio broadcasting.

Foreign satellites will also have allowed to be used in special circumstances for satellite communication services in India. The service licensing departments may allow the use of foreign satellites only in consultation with the Department of Space. If suitable capacity/capability is available in INSAT or Indian Satellite Systems, operations with foreign satellites will not be permitted. For the use of foreign satellites for Internet Service Provider (ISP) gateways, the existing procedures established by Telecom Commission will apply.

12.2.5.3 India's Space Policy[10]

Remote sensing

Recognizing that Remote Sensing data provides much essential and critical information - which is an input for developmental activities at different levels, and is also of benefit to society.

Noting that a large number of users - both within and outside government, use Remote Sensing data from Indian and foreign remote sensing satellites for various developmental applications.

Taking into consideration the recent availability of very high-resolution images, from foreign and commercial remote sensing satellites, and noting the need for proper and better management of the data acquisition/ distribution from these satellites in India.

Recognizing that national interest is paramount, and that security consideration of the country needs to be given utmost importance.

The Government of India adopts the Remote Sensing Data Policy (RSDP) - 2011 containing modalities for managing and/ or permitting the acquisition / dissemination of remote sensing data in support of developmental activities. Department of Space (DOS) of the Government of India shall be the nodal agency for all actions under this policy, unless otherwise stated.

1. For operating a remote sensing satellite from India, license and/ or permission of the Government, through the nodal agency, shall be necessary.
    - As a national commitment and as a "public good", Government assures a continuous and improved observing/ imaging capability from its own Indian Remote Sensing Satellites (IRS) programme.

[10] https://www.isro.gov.in/indias-space-policy-0

- The Government, through the nodal agency, shall be the sole and exclusive owner of all data collected/ received from IRS. All users will be provided with only a license to use the said data, and add value to the satellite data.
- Government reserves the right to impose control over imaging tasks and distribution of data from IRS or any other Indian remote sensing satellite, when it is of the opinion that national security and/ or international obligations and/ or foreign policies of the Government so require.
-

2. For acquisition/ distribution of remote sensing data within India, license/ permission from the Government of India, through the nodal agency, shall be necessary.
   - Government reserves the right to select and permit agencies to acquire/ distribute satellite remote sensing data in India. DOS shall be competent to decide on the procedure for granting license/ permission for dissemination of such data, and for the levy of necessary fees.
   - To cater to the developmental needs of the country, the National Remote Sensing Centre (NRSC) of the Indian Space Research Organisation (ISRO)/ DOS is vested with the authority to acquire and disseminate all satellite remote sensing data in India, both from Indian and foreign satellites.
     - NRSC shall enter into appropriate arrangements with DOS for acquiring/ distributing data from IRS within the visibility circle of NRSC's receiving station(s).
     - NRSC and/ or Antrix Corporation Ltd., shall be competent to enter into agreements with foreign satellite operator(s) for acquisition/distribution of foreign satellite data in India. However, NRSC will distribute the data as per terms agreed to with Antrix Corporation Ltd.
   - NRSC shall maintain a systematic National Remote Sensing Data Archive, and a log of all acquisitions/ sales of data for all satellites.
3. For acquisition and distribution of IRS data for use in countries other than India, the Government of India, through the nodal agency, shall grant license to such bodies/ agencies of those countries as are interested in the acquisition/ distribution of IRS data, as per specific procedures.
   - The Antrix Corporation Ltd. (of DOS) is vested with the authority for receiving the applications for grant of license for acquisition/ distribution of IRS data outside of India; to consider and decide on the granting of license within the policy considerations of the Government, and to enter into licensing agreements with the prospective users on behalf of the Government. Antrix Corporation Ltd. shall also be competent to levy such fees for granting licenses as may be considered appropriate by it. It shall also be responsible, where necessary, for rendering any further help/ guidance needed by the license.
   - The Government reserves right to impose restrictions over imaging tasks and distribution of IRS data in any country when it is of the opinion that national security and/ or international obligations and/ or foreign policies of the Government so require.
4. The Government prescribes the following guidelines to be adopted for dissemination of satellite remote sensing data in India:
   - All data of resolutions up to 1 m shall be distributed on a non-discriminatory basis and on "as requested basis"

- With a view to protect national security interests, all data of better than 1 m resolution shall be screened and cleared by the appropriate agency prior to distribution; and the following procedure shall be followed:
  - Government users namely, Ministries/ Departments/ Public Sector/ Autonomous Bodies/ Government R&D institutions/ Government Educational/ Academic Institutions, can obtain the data without any further clearance.
  - Private sector agencies, recommended at least by one Government agency, for supporting development activities, can obtain the data without any further clearance.
  - Private sector agencies, recommended at least by one Government agency, for supporting development activities, can obtain the data without any further clearance.
  - Specific requests for data of sensitive areas, by any user, can be serviced only after obtaining clearance from the HRC.
  - Specific sale/ non-disclosure agreements to be concluded between NRSC and other users for data of better than 1 m resolution.

5. This Policy (RSDP-2011) comes into effect immediately, and may be reviewed from time-to-time-by Government.

12.2.6 Spaceflight (US)

I contacted spaceflight:

12.2.6.1 RE: [External] - Sales - Website Submission

November 17, 2021 6:31 am 52 KB
From:

Keiko Nasu <knasu@spaceflight.com>
To:

siham.aisha@temo-group.com

Hello,

Sorry, for some reason your e-mail has been in the spam box and it took me a while to find your response. I deeply apologize for that.
We are just to close the manifest for June 2022 SpaceX rideshare. We need to provide a good portion of deliverables to SpaceX by December 1, but if you will be able to do that, we might be able to launch your satellite with that mission.
The issue is how you would like to separate the 2 satellites. Our Sherpa-OTV could provide in-plane phasing but it's not going to be very economical for 2U satellite (and I heard that our Sherpa capacity is already filled).
We might be able to separate a little bit by delay the second satellite deployment (30min or so at most), but it will not give you a lot of separation.
Please confirm SSO is the orbit you would like to go, and will check other possible launch options.
Let me know if you prefer to have a brief call.
Warm regards,

Keiko Nasu
Business Development, Spaceflight Inc.
KNasu@spaceflight.com

Mobile:+1-206-384-0678

From: Siham <siham.aisha@temo-group.com>
Sent: Monday, November 15, 2021 1:36 AM
To: Keiko Nasu <knasu@spaceflight.com>
Subject: RE: [External] - Sales - Website Submission

hello,
I'm waiting for response.
another question: what is the procedure to launch a satellite ?

Regards,
Siham

On October 2, 2021 at 9:20:37 am +03:00, Siham <siham.aisha@temo-group.com> wrote:
Hello Keiko,

1- the time frame it's about in the middle of 2022
2- launch to the same inclination, I mean in the same orbit
3- our spacecraft don't have propulsion
4- size of our spacecraft is : 10X10X20 cm 2U for 2 satellites
5- mass is: 3Kg
6- the purpose: small pilot system for communication satellite.

Regards,
Siham

On September 29, 2021 at 1:34:32 am +03:00, Keiko Nasu <knasu@spaceflight.com> wrote:

Hello Siham,

Thank you so much for reaching out to us.

In order to figure out the launch options and pricing, could you provide below?

- What is the time frame you are looking to launch?
- What orbit do you want to launch your spacecraft to?

-> Do you mean to launch to Mid-inc? 45 degrees inclination, Or you would like to launch to the same inclination but do the plane phasing?

- Will your spacecraft have propulsion?
- What is the size of your spacecraft?

->2U x 2 satellites

- What is the mass of your spacecraft?

- What is the purpose of your spacecraft?

  Thank you!

Keiko Nasu

Business Development, Spaceflight Inc.

KNasu@spaceflight.com

Mobile:+1-206-384-0678

13 Tasks and Responsibilities, Technical Documentation

	Working Package	**Responsible**	**Name of Technical Documentation**	**Department/ Stakeholder**
1	CoreFlightSystem, on-board computer	Samir	**System Design**	**ICS**
2	Attitude control system	Raja	ACDS Technical Report	**ICS**
3	AIS	Rozan	AIS Clustering	**Marmara University, Istanbul, Faculty of Computer Science**
4	Telemetry and payload COM system, intersatellite communication	Abd	**COM/OBD**	
5		Yahya	X-Ray Sensor	**IAP**
6	Ground station	new Turkish bachelor student group	Ground Station	
7	Launching issues	Siham	**Orbit and Altitude Specification, Legal issues, pre-launch activities**	
8			**Vibration damper**	
9			**Thermal Isolation**	

13.1.1 Summary of System Parts

MAGNETOMETERS - Magnetometers sense magnetic field strengths and direction. The measurements are compared to the Earth's magnetic field map (which is dependent on the spacecraft position) to determine the attitude. Moreover, it can only be used at low altitude orbits, where the magnetic field is strong enough.

13.1.2 Status of Hardware

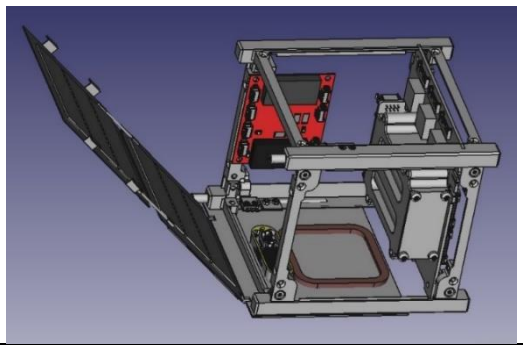
Hardware	Status
Onboard Computer	Received
Solar Cells	Received
Power System	Ordered – 10 Week Lead Time
Chassis	Ordered – Unknown Lead Time
ITC Designed Solar Panel PCBs	Designed – Out for Quote
Radio	Ordered – 6 Month Lead Time
Clean Room	Procured and Setup for Ribbon Cutting
Deployable Antenna	Ordered – Unknown Lead Time
Camera	Received

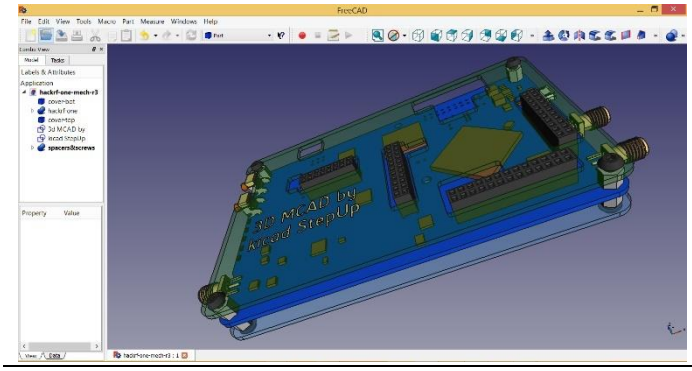
13.1 Project Documents & Databases for AS-COMSAT-1 (1 Satellite 10cmx10cmx10cm) (Last update: 8.4.21)

13.1.1 Development Documents

Development Phase	Name of Document	Purpose/Content
Analysis	Fire Detection System Description Presentation	about 130 pages Project Description, Supplier Parts
	Initial Cost Estimation	381,000 $ for satellite and ground station (including launch)
Systemdesign	System Design Document	
Mechanical Design		
Hardware Design	HackRF	
SW Specification	Software Specification Document (SDS)	on OBC and HackRF
SW Design	Software Design Document (SDD)	

13.1.2 Mechanical CAD Models

AS-COMSAT- 1 Integration	
Payload 1 (X-Raysensor)	9,5 cm x 2,5 cm x 7 cm
PV Cells and Controller	
Load Controller&Batteries	
Magnetorquer	
Sun Sensor (Photocell)	

On-Board-Computer (OBD)	Raspberry Pi 3
SDR (HackRF) (TT&C and Payload COM)	

13.2 Task "Ground Station"

بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

Anadolu-Sham COMSAT

07.10.21

Task (Bachelor Thesis/Student Project)

Development of a Ground Station for a system of 4 LEO satellites (AS-COMSAT_1)

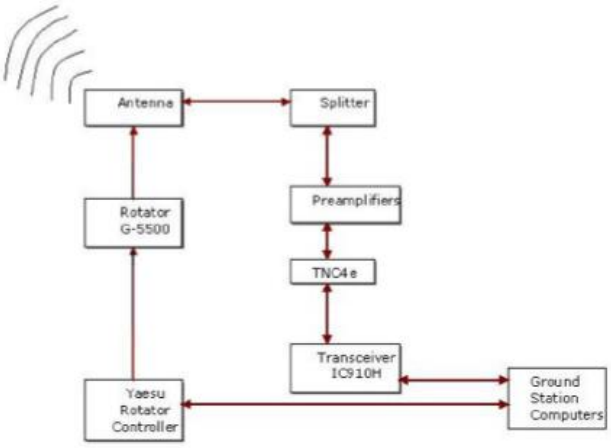
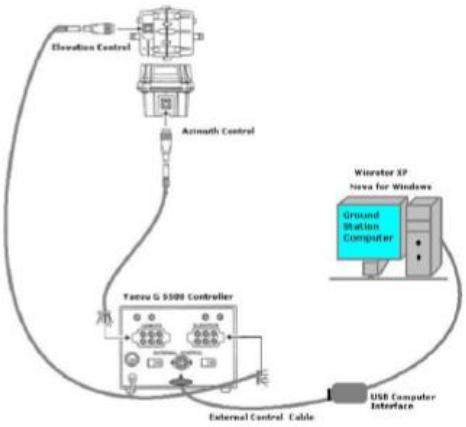


Figure 1.4: Block Diagram of the Ground Station.



Rotor-Controller-Computer Interfacing.

Graphical User Interface

14 Suppliers

14.1 CNC

Company	Phone number	Description	Address	E-mail, web site
CNC LAB	06 412 895 03 476 916	Manufacture 3D design in plastic & open source hardware	Tripoli,Lebanon Bahsas,Behind Haykalieh Hospital, Harba Bld.	www.cnclab.com info@cnclablb.com
Hasan Al Baba	03 828 256	Manufacture and casting	Tripoli, Lebanon Mina, Industry and Commerce street	
HI-Tech fabrication Fawaz Abdel Hadi	06 442 787 70 751 522	Precision mechanical parts manufacturing brass & steel marking heads maker	Tripoli, Lebanon Mahjar suhi P.O. Box 1274	www.hitechfabrication.com info@hitechfabrication.com sirfawaz@yahoo.com
Hannuf mechanical 'Corporation for casting and art construction	06 387 723 03 717 107	Manufacture and casting	Tripoli, Lebanon Al Badawi	
GPS Steel	03 196 225	Uses electric discharge machining process to shape any metal material rapidly by using desired modeled electrodes	Beirut, Lebanon Burj Hammoud	Gps.steel.co@gmail.com
Riyako factory	79 118 779	3D CNC machine, manufacture cupboard for cars	Tripoli, Lebanon Badawi, behind Al Ridani bakery	

14.2 Contact data of specialists (معلم), workers, ...

Specialist for / price	Name	Address	Phone
Aluminium, 80$/qm	عمر	بعبدة – عكار	70 140828

15 References

[1] Jana Othman, AECENAR Internship report, 3.Sep 2021

[2] http://aecenar.com/index.php/downloads/send/16-ics/666-temoleb-mintad-final-report-1999-2020

[3] *Development of a GS Package suited for Spacecraft Operation Control and Optimization methods for Satellite flyby over the Ground Station*, Raj Gaurav Mishra, Master Thesis at University of Wuerzburg, Germany, 2007

[4] A DESCRIPTION OF A STANDARD SMALL SATELLITE GROUNDSTATION FOR USE BY WMO MEMBERS, TECHNICAL DOCUMENT WMO/TD No. 660, 1995