CanSat Leader Training Program (CLTP) - 8th Cycle

Final Presentation

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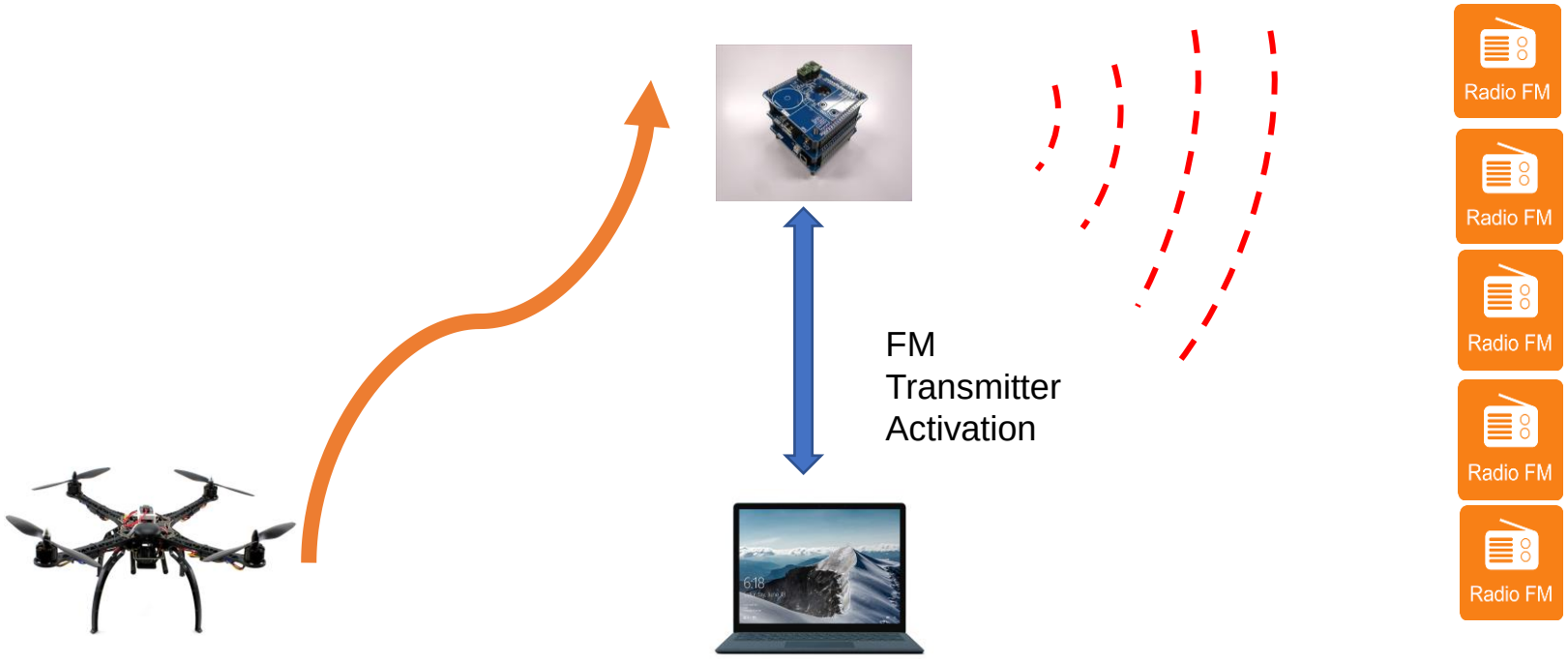
Mission Statement

“FM transmission in a commercial Band with the HeptaSAT”

Level of Success Criteria	Achievement
Minimum	Housekeeping data transmitted to the Ground Station
Medium	Partial Time transmission of a siren
Full	Transmission of “Ode to Joy” during the whole falling time

Voice Transmission in FM (One Way)

Graphical Concept



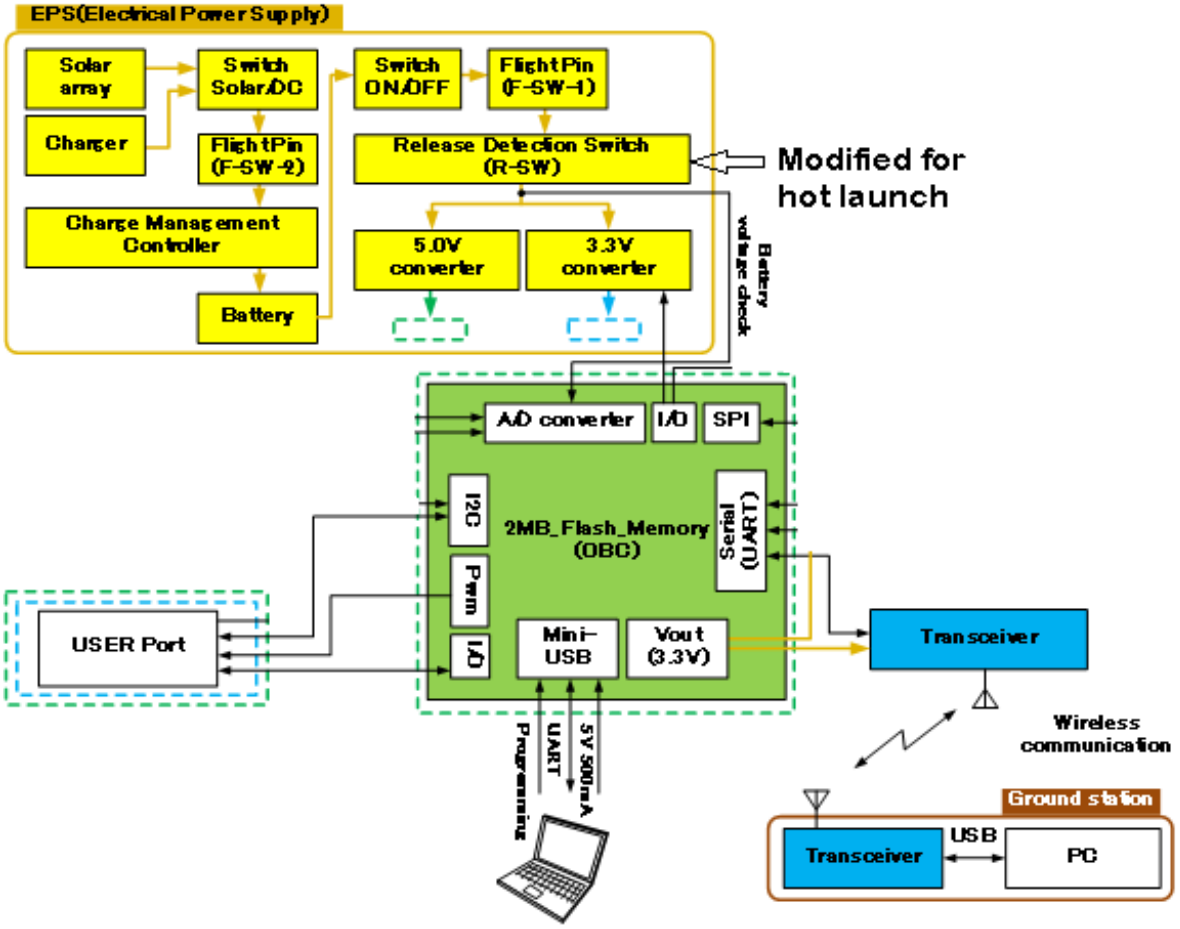
People around the Launching site will be holding an FM radio so they can listen to the song being transmitted after the HeptaSAT is dropped.

Mission Requirements

No	Event	Requirement
R-1	Preparation Phase	Start HeptaSat
R-2		Battery charge OK
R-3		Xbee communication
R-4		FM transmitter OK
R-5	Standby Phase	HeptaSat waiting for command while 3.3V is OFF
R-6	Launch Phase	Receive Telecommand
R-7		Send Housekeeping Data
R-8	Mission Phase	FM signal activation
R-9		FM signal deactivation
R-10	Analysis Phase	FM Signal Quality
R-11		Coverage Area

Bus System Architecture

- The Bus System is based on the HeptaSAT architecture
- It only uses the components in the graphic



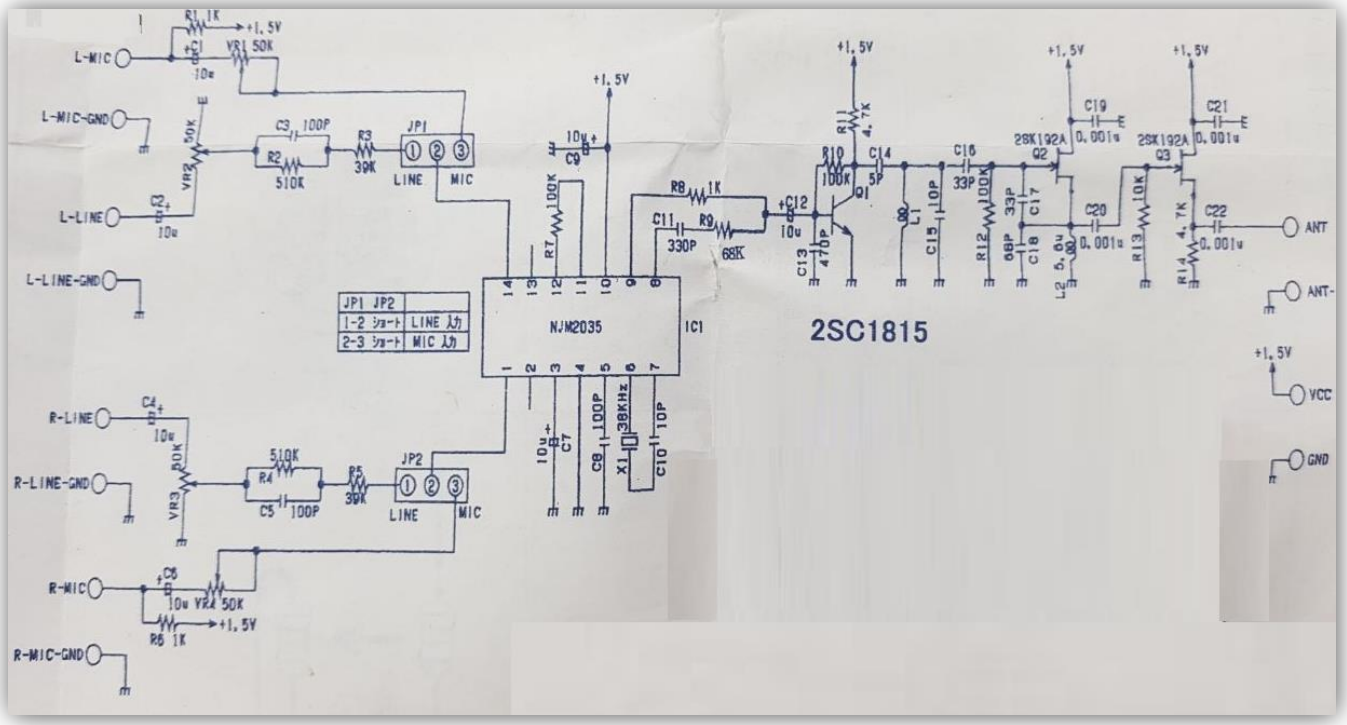
Bus Subsystems

- Although all sensors are mounted, not all of them are used
- It uses “mbed.h, HeptaXbee, HeptaBattery.h and SongPLayer.h” libraries
- For the mission requirements EIGHT telecommands have been implemented divided by FOUR operation modes.
- These telecommands are: Start up, Battery check, Communication Check, Sound Emitting Test(Siren), Stand By, Full operation, FM transmission and FM turning OFF.
- 134 lines of code for main()

Payload Subsystem Architecture

FM Transmitter

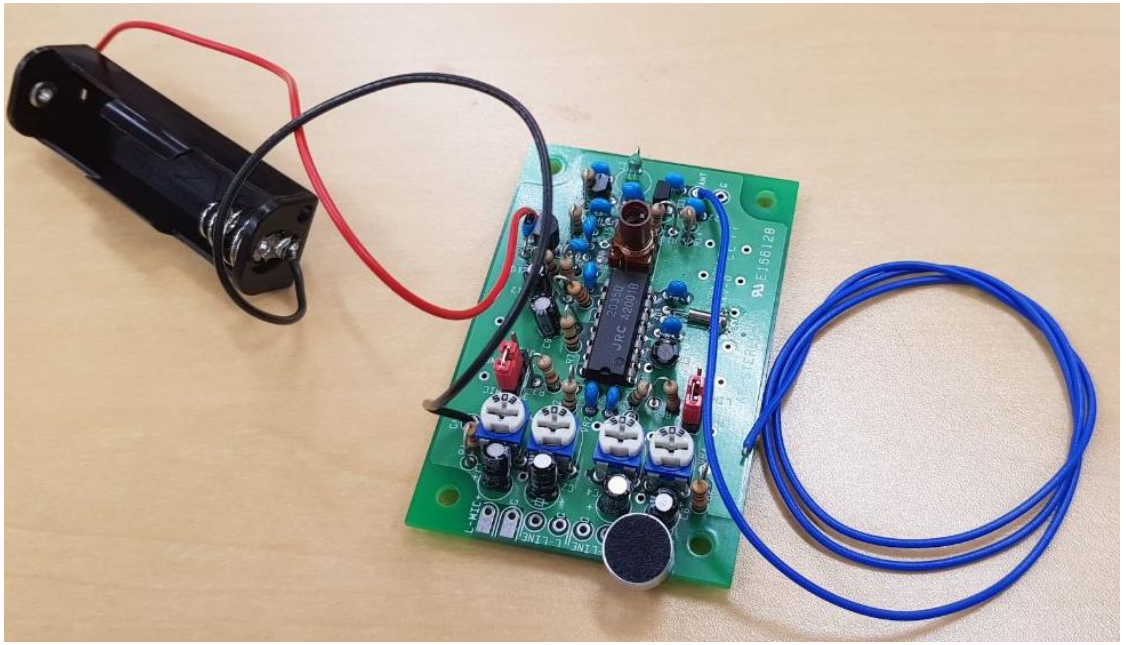
- **Bandwidth separation of 19 KHz for Stereo**
- **Range of 76MHz to 90MHz**
- **Best signal acquisition at 89.5MHz in Nihon Univ.**



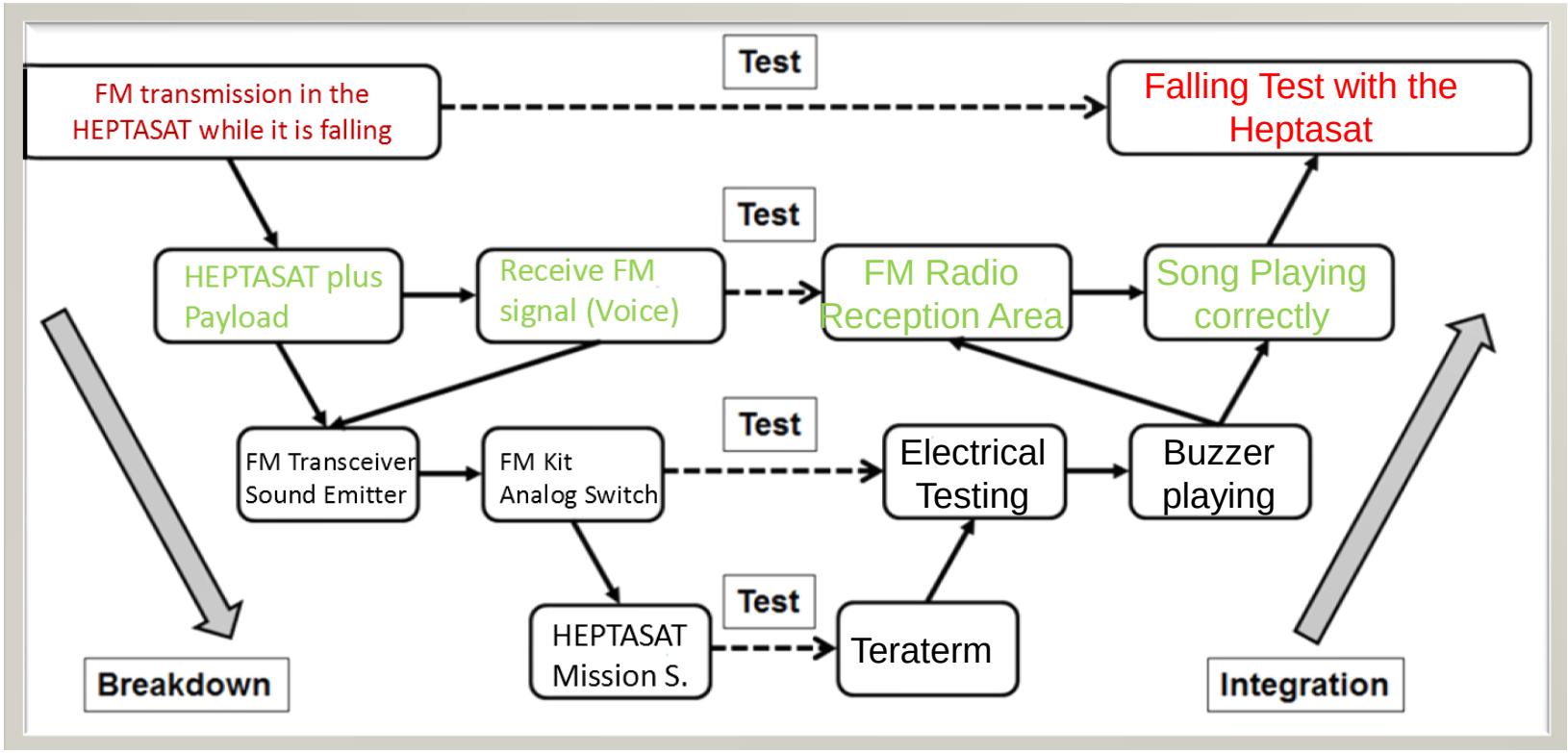
Payload Subsystem Architecture

FM Transmitter

- **56 Components Soldered on a PCB and one Simple Cable of 30 cm attached as an antenna**
- **The signal can be acquired +/-500KHz of the central frequency**



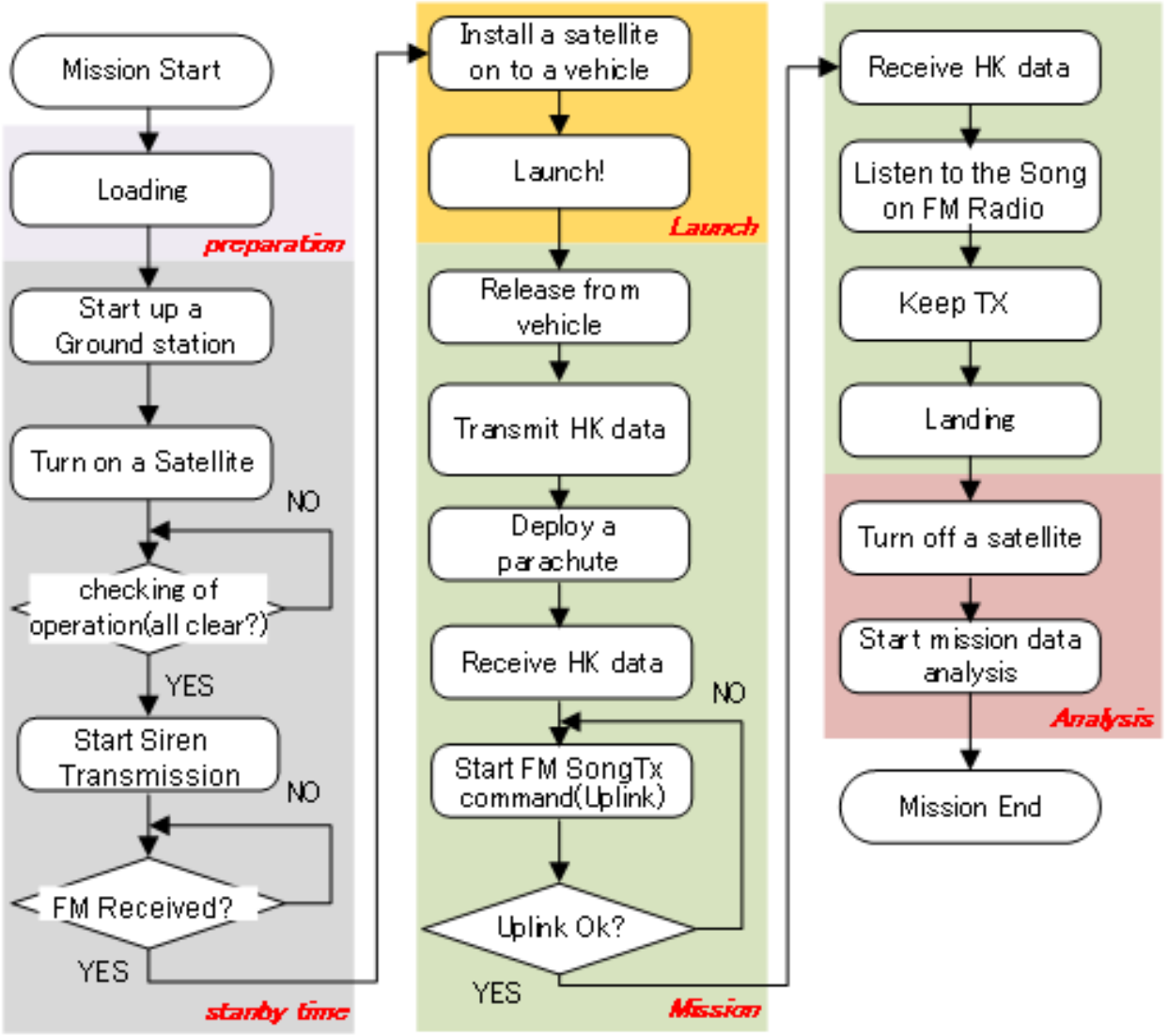
Validation and Verification Plan/Testing



Mission Requirements

No	Event	Requirement	Required Function	Verification Way
R-1	Preparation Phase	Start HeptaSat	Turn HeptaSat Switch to ON	Teraterm
R-2		Battery is charged	Acquire Voltage of the Battery	Teraterm
R-3		Xbee communication	Uplink/Downlink Confirmation	Teraterm
R-4		FM transmitter OK	Activation/Deactivation of PWM signal for test	FM Radio 89.5 MHz Teraterm
R-5	Standby Phase	HeptaSat waiting for command	Turn off 3v3 Module	Teraterm
R-6	Launch Phase	Receive Telecommand	Function for Telecommand	Teraterm
R-7		Send Housekeeping Data	Function for Telemetry	Teraterm
R-8	Mission Phase	FM signal activation	Activation of "Ode to Joy" song	FM Radio 89.5 MHz Teraterm
R-9		FM signal deactivation	Stop playing the song	FM Radio 89.5 MHz Teraterm
R-10	Analysis Phase	FM Signal Quality	Listening to the song	Testimonies
R-11		Coverage Area	Mapping	Plotting

Mission Sequence



Flight Result: First Attempt

Experiment Conditions

Weight [g]	Wind Velocity [m/s]	Altitude [m]	Time [s]	FM Central Frequency [MHz]
400	2.6	65	25	89.5

Results by phases

Preparation	Stand by	Launch	Mission	Analysis
✓ HeptaSAT turned ON	✓ Turned to Stand-by	✓ Siren Mode ON	✓ FM Tx Command Received	X FM signal acquired
✓ Battery > 3.7	✓ Confirmation via GS	✓ HK data OK	✓ “Ode to Joy” Tx started	✓ Large Area of coverage
▪ (4.2V)		✓ Siren Sound on FM radio	X FM reception	✓ Directional Transmission
✓ Xbee Communication			✓ FM Stop Command Received	
✓ Siren Sound on FM Radio			✓ “Ode to Joy” Tx stopped	

Flight Result: Second Attempt

- FM Tx Battery Changed
- Hotter Launch
- Reception of one FM Radio

Experiment Conditions

Weight [g]	Wind Velocity [m/s]	Altitude [m]	Time [s]	FM Central Frequency [MHz]
400	2.2	50	16	**87.5**

Results by phases

Preparation	Stand by	Launch	Mission	Analysis
✓ HeptaSAT turned ON	✓ Turned to Stand-by	✓ "Ode to Joy" ON	✓ FM Reception on Radio at 20m altitude	✓ Small Area of coverage
✓ Battery > 3.7	✓ Confirmation via GS	✓ HK data OK	✓ FM Stop command	✓ Directional Transmission
▪ (3.9V)		✓ "Ode to Joy" on FM radio until 20m altitude	✓ Rx Command Received	
✓ Xbee Communication			✓ "Ode to Joy" Tx stopped	
✓ Siren Sound on FM Radio			✓ HK data received	

Flight Result: First Attempt Testimonies

- "…I could hear some funny song, but it wasn't Ode to Joy…"
- "…I could hear sounds only before the Drone reached its high altitude, then nothing…"
- "…I couldn't hear anything…"
- "…I couldn't hear anything except before launching and after landing…"

Flight Result: Second Attempt Testimonies

- "…I could hear Ode to Joy during the launch and landing, but only when it was close to the ground…"

No coverage map was done due to lack of FM radio receivers

Conclusions

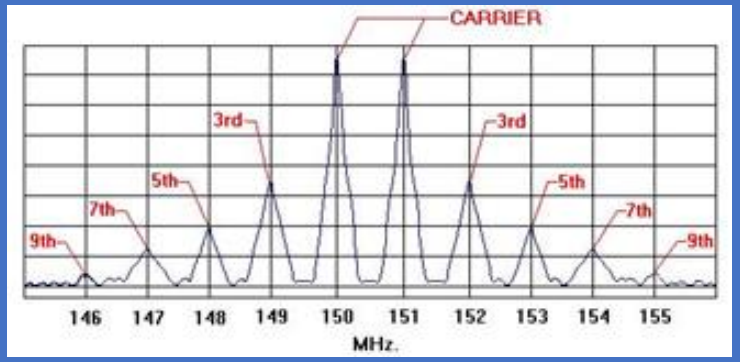
- FM signal couldn't be received during the whole falling time, but only when the HeptaSAT was close to the ground

→ MEDIUM TO FULL SUCCESS!

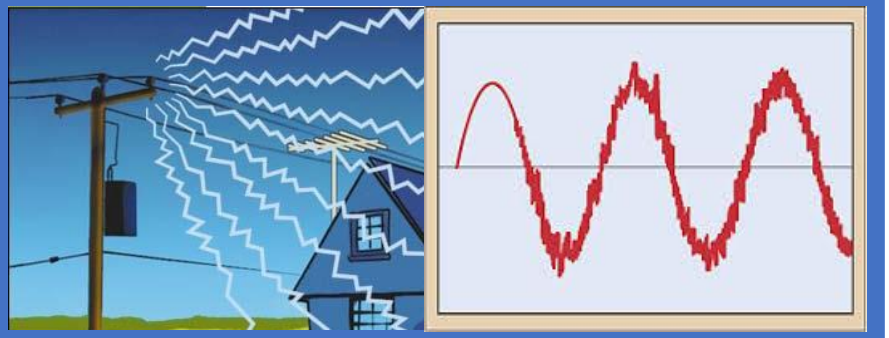
- The acquired FM signal wasn't bigger than the MDS due to many reasons:
  - ❑The radio wave interference at the launch site
  - ❑The intermodulation interference at the launch site
  - ❑The electrical interference
  - ❑Low Power from the Tx Transmitter
  - ❑Loss due to wrong polarization

Conclusions

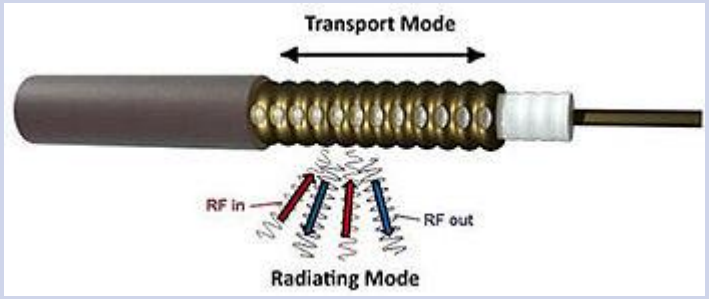
Intermodulation Interference
Strong FM stations in other freq.



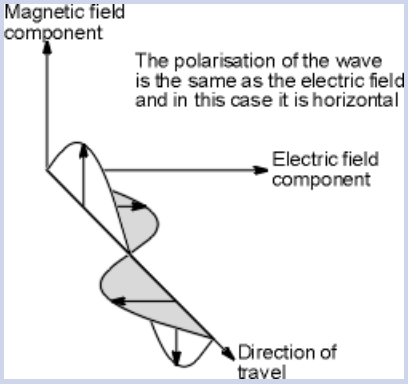
Electrical Interference
Drone, Electric Towers nearby

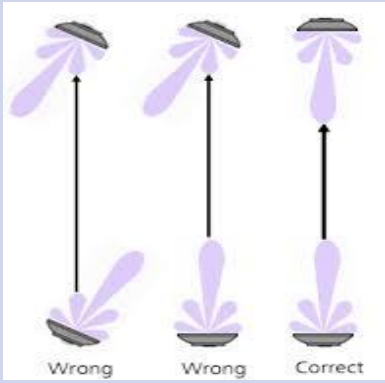


Low Power
Not suitable antenna, medium power design of the transmitter, $\lambda/4$



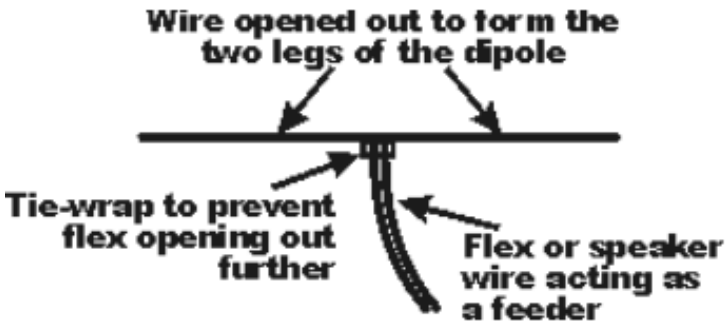
Loss due to wrong polarization

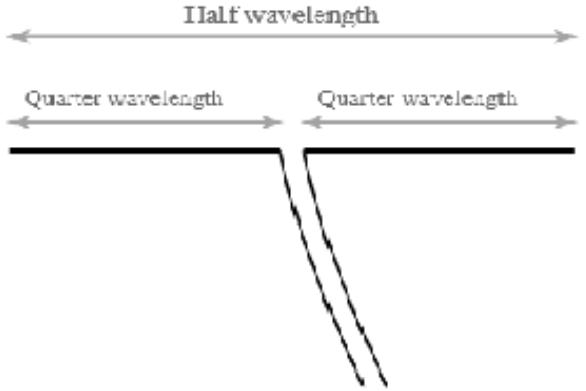




Recommendation and Future Work

- Perform Field Tests to find the best suitable FM central freq.
- Use a more powerful transmitter
- Design an antenna based on the wavelength:





- Implement a Lowpass filter
- Connect Grounds of both circuits

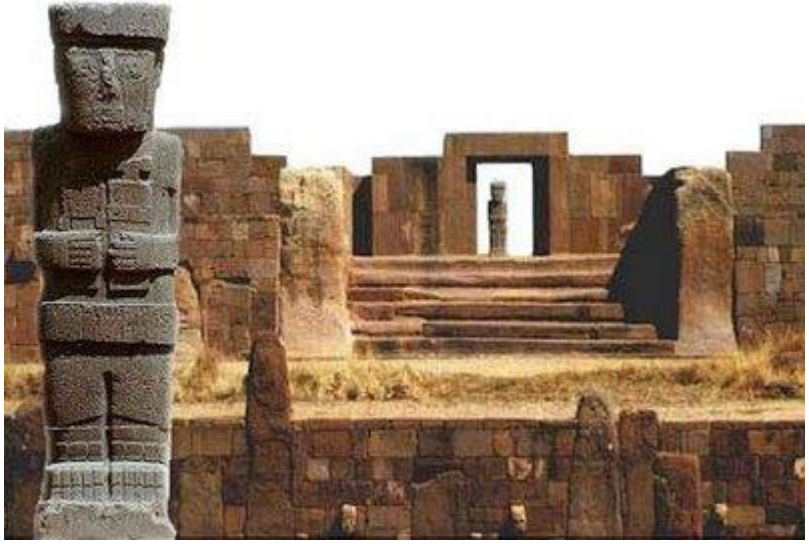
After these recommendations, even a larger range test can be performed!

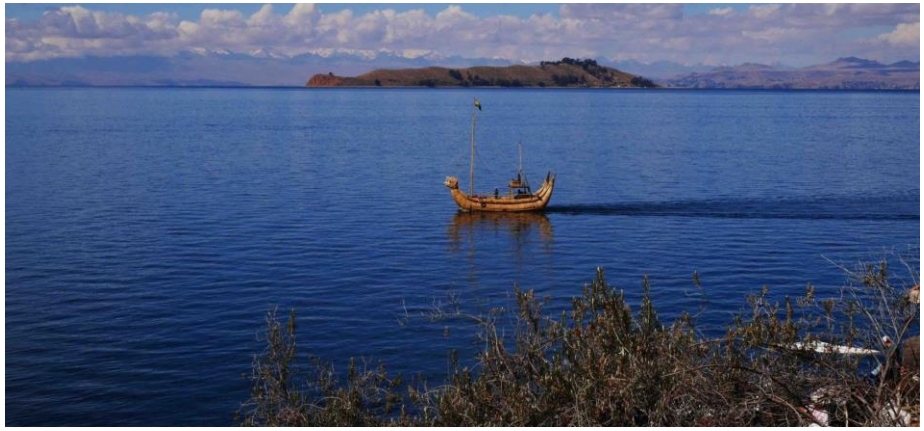
Future work: develop a more robust program to play mp3 files

Feedback and Recommendation for CLTP

- The HeptaSAT is a great tool for hands-on training that involves the participant involved in each and every one of the satellite subsystems
- The EPS design process was very well explained and detailed: requirements were stated, and after calculations a solution was implemented
- The teaching staff was very friendly and patient
- The design process of other subsystems should be like the EPS'
- A little table of the components selection should be made after each subsystem is presented, so participants can understand why each component was selected over other options
- One more day was needed for a better mission design, implementation and tests

Cansat Leader
CLTP
Training Program





VIVE Bolivia

I will always remember the hospitality and human warmth brought by the Japanese at the CLTP

Thank you very much!!!

Dōmo arigatōgozaimashita!!!

どうもありがとうございました!!!