HASP Payload Specification and Integration Plan

Payload Title: Scarlet Hawk III

Payload Class: **Small** Large (circle one)

Payload ID: 2015-05

Institution: Illinois Institute of Technology (IIT)

Contact Name: Caterina Lazaro

Contact Phone: 312 731 7549

Contact E-mail: clazarom@hawk.iit.edu

Submit Date: 4/24/2015

I. Mechanical Specifications:

A. Measured weight of the payload (not including payload plate)

Component Name	Mass (grams)
Electronics	
Arduino	35
HackHD Camera	~20
Sensors (x7), 3g each	21
Components	~5
Cables and Connectors	~15
	Total ~ 96
Communications	
FPGA	50
ADC	102
Additional board	100
Antenna	50
	Total ~302
Structure	
Angle Frame	194
Small Metal X Plates x3	147
Large Metal X Plates x4	369.5
All Screws and Hex Nuts	30
FRP 4 Sides & Top	~450
	Total ~ 1,190.5

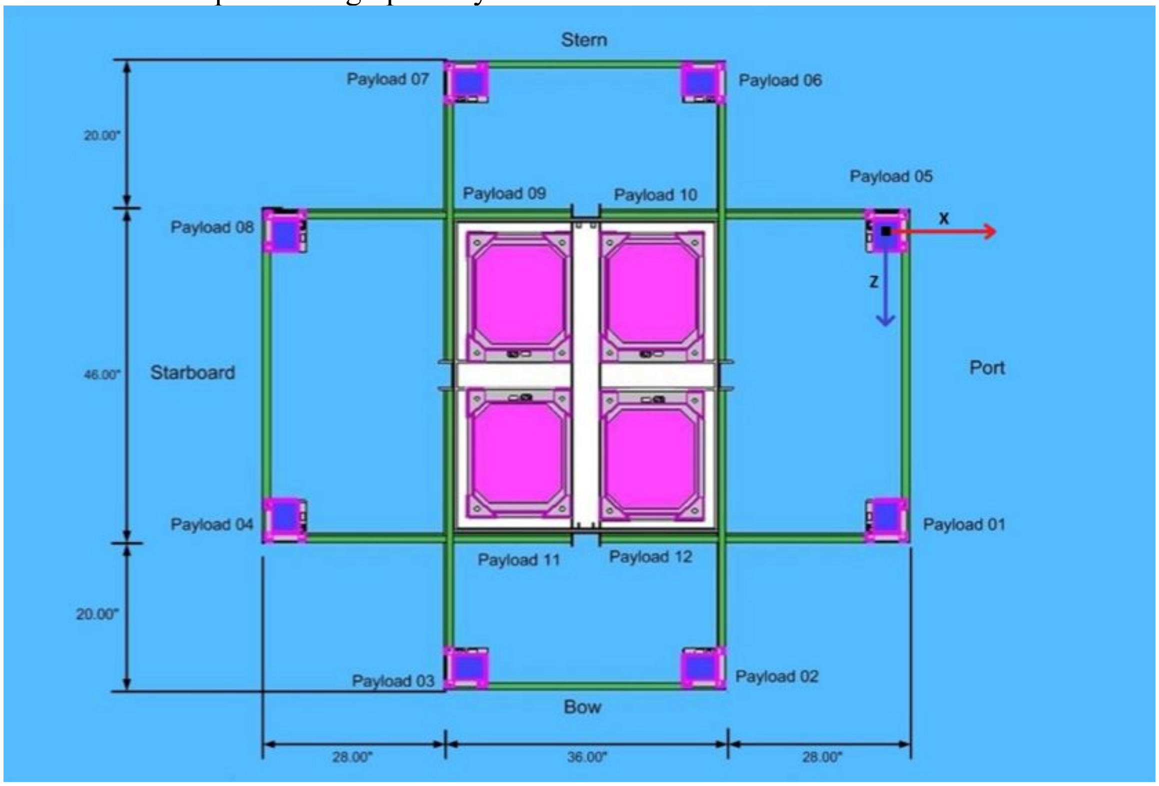
Miscellaneous	300
NET TOTAL	~ 1888.5

Note: *(~) indicates estimate rather than measurement. All masses rounded to the nearest half-gram.*

(*)Including a possible Battery mass of 82.6g, NET TOTAL ~ 1971.1

B. Provide a mechanical drawing detailing the major components of your payload and specifically how your payload is attached to the payload mounting plate

- As with our last structure, the payload will be oriented such that the side with the outer connectors faces the platform, while the side with the cameras points counter to it. This can be represented graphically as follows:



Looking at Payload 05 in the drawing above, the payload's side-facing camera will be pointed along the x-axis to obtain an unobstructed view of its surroundings. The side of the payload with connectors will be facing HASP directly.

The image below shows the positioning of the payload when mounted on HASP. Note that the first photo is from last year's payload. With the exception of the solar panels, this year's payload will be identical. The secondary photos identify what is unique to this year's payload—its attachment to both baseplate and HASP platform.

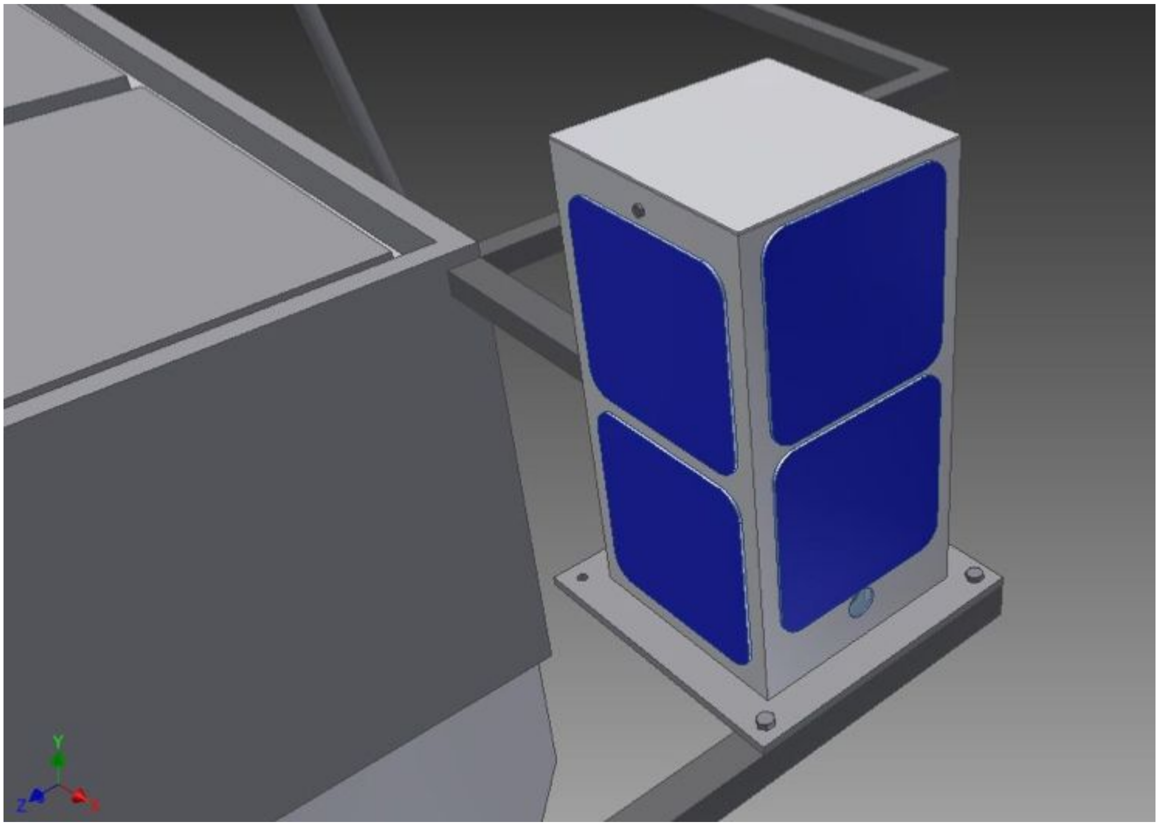


Photo 1: *Similar to last year, though ignore solar panels (note coordinate system)*

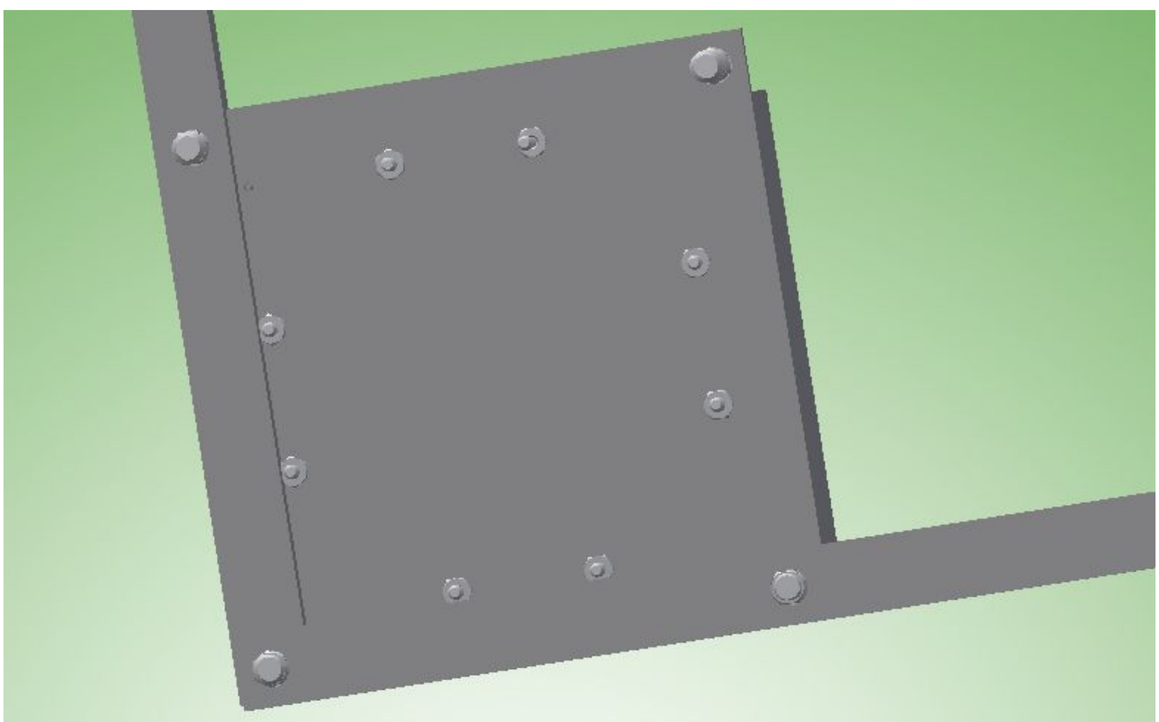


Photo 2: *Baseplate attachment to platform, as well as payload attachment to plate*

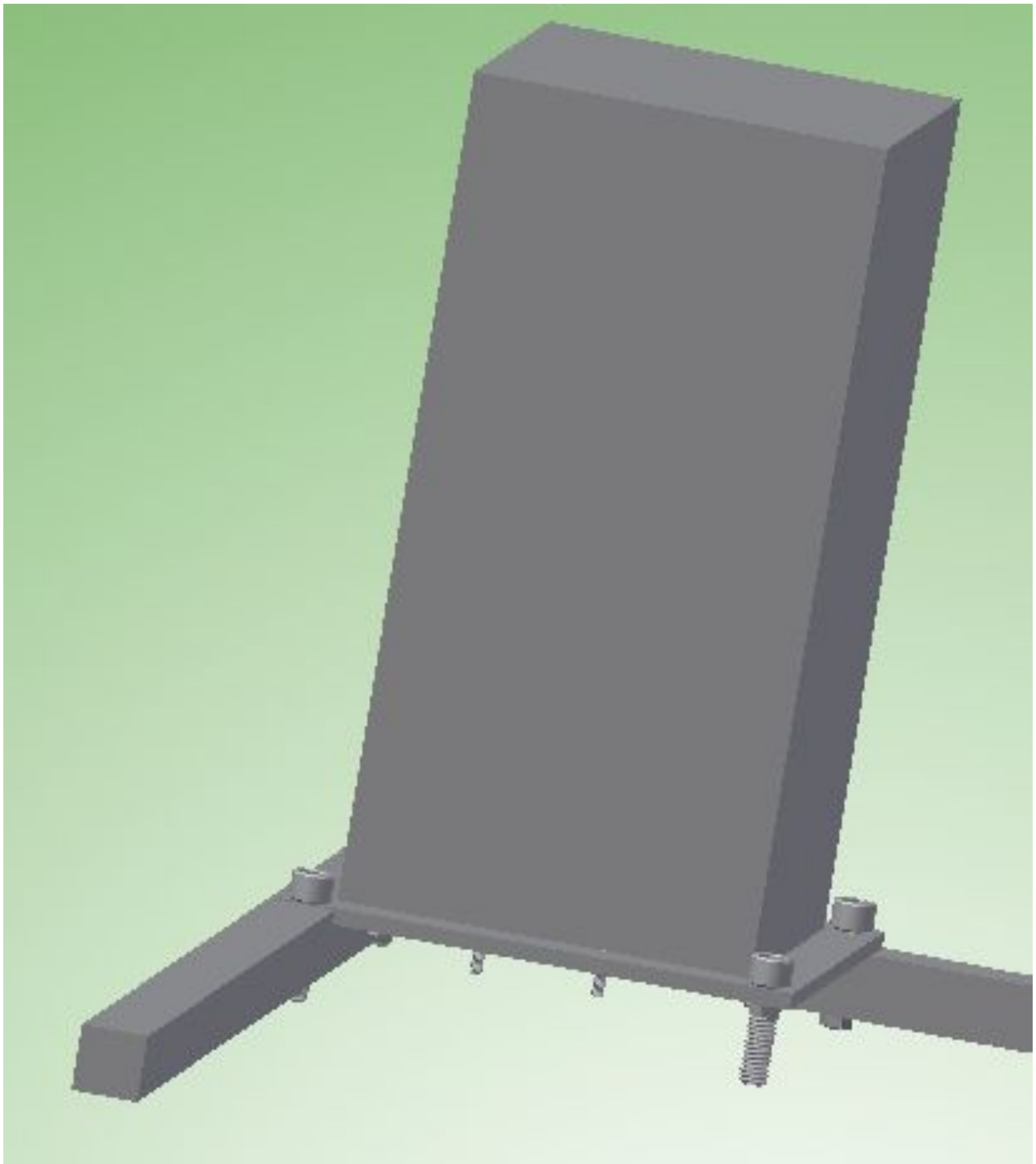


Photo 3: *Attachment as seen from the side*

C. If you are flying anything that is potentially hazardous to HASP or the ground crew before or after launch, please supply all documentation provided with the hazardous components (i.e. pressurized containers, radioactive material, projectiles, rockets…) No hazardous materials will be on board

D. Other relevant mechanical information

- Though not shown, there will be additional punctures made to the FRP for camera and antenna. There will also be additional holes made to the baseplate as components dictate.
- Due to size constraints, we will not include the ABS plastic box (for holding the circuit boards) that was outlined in our original proposal.
- Our hope is that this year's payload design allows our structure to be reused in coming years.

II. Power Specifications:

A. Measured current draw at 30 VDC

Since the board isn't printed yet the following calculations are approximations and might not be accurate, we will get the correct measurements when the board is done.

For Arduino and sensors the current draw is as follows:

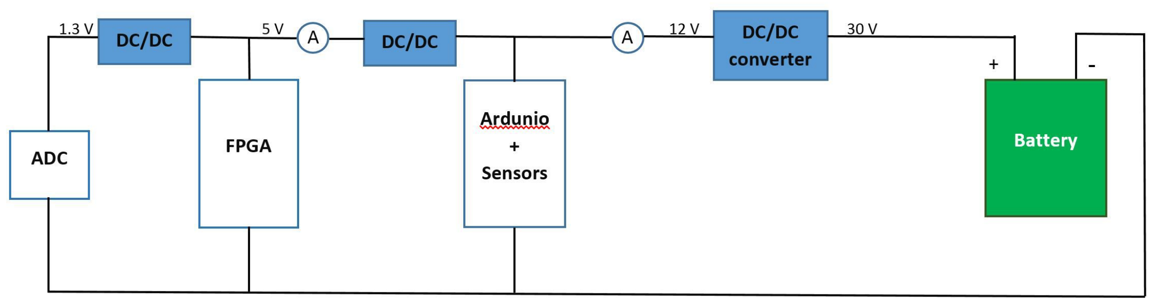
Component	**Quantity**	**Maximum current**
TMP006 sensor	x2	10 mA x 2 = 20 mA
HIH 6130 sensor	x1	1 mA
BMP085 sensor	x1	0.1 mA
INA 219 sensor	x1	10 mA
Photocell	x1	1 mA
Hack HD Camera	x1	1 mA
Arduino	x1	80 mA
FPGA	x1	200 mA @ 5V (*)
ADC	x1	350 mA @ 1.3V(*)
Total	**+ 10% margin**	**731 mA = 0.73 A**

(*) The current draw @30V will be less than the one showed in this table. The total maximum current should be lower than 0.5A, but, just in case, we have a battery of 1.5V for the ADC.

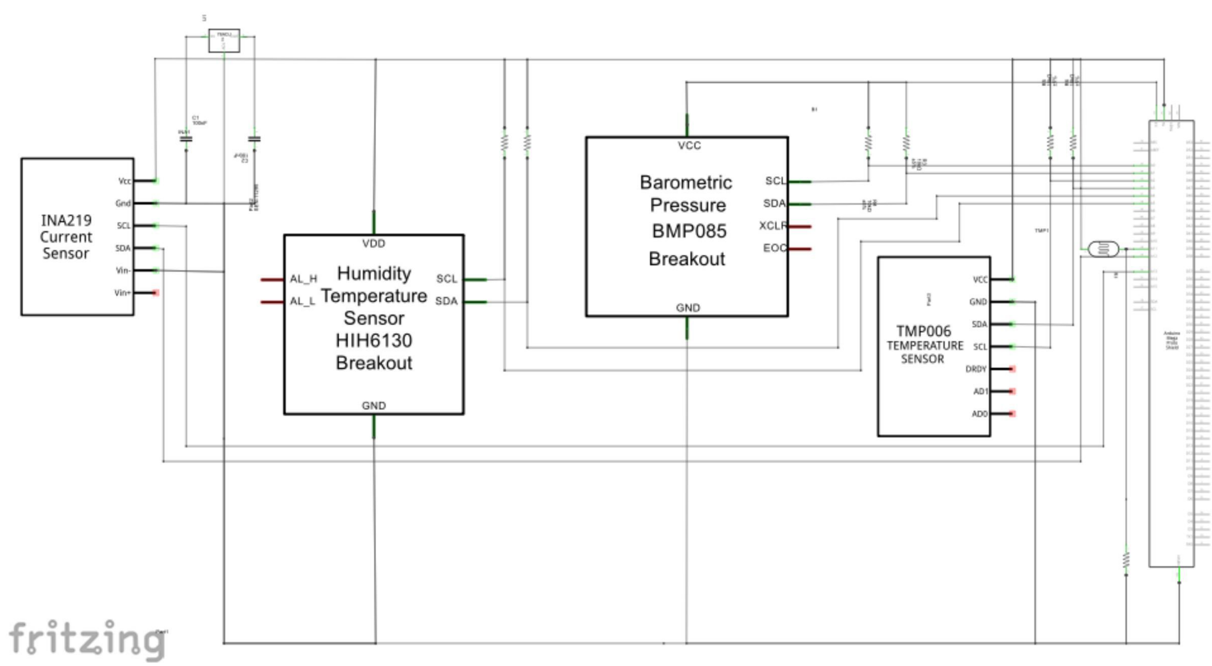
B. If HASP is providing power to your payload, provide a power system wiring diagram starting from pins on the student payload interface plate EDAC 516 connector through your power conversion to the voltages required by your subsystems.

The connection to the EDAC 516 connector is a simple connection using 3 DC/DC converters to downgrade from 30V and get 12V, 5V and 1.3V to supply all the components.

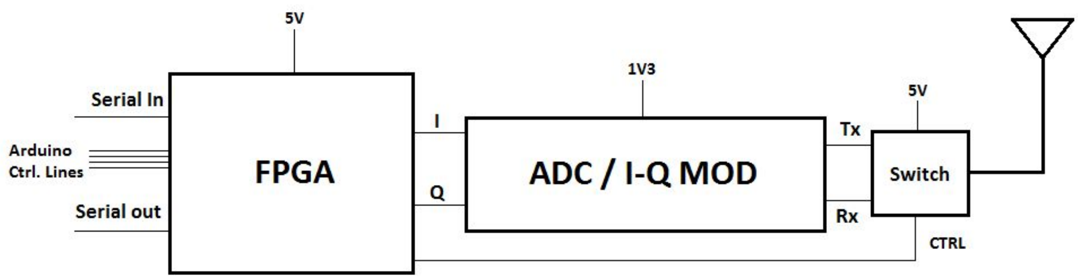
The power diagram looks as follows:



The following schematics show the detailed power connections to the Arduino and sensors:



The following schematics show the detailed connections of the communication systems:



C. Other relevant power information

III. Downlink Telemetry Specifications:

A. Serial data downlink format: Stream Packetized (circle one)

B. Approximate serial downlink rate (in bits per second)

30 bits per second.

C. Specify your serial data record including record length and information contained in each record byte.

$<S_{Tmp1}><S_{Tmp2}><S_{Hdty}><S_{Pressure}><S_{Light}><S_{Camera}><A_1><A_2><f_{com}><Mod_{com}><Checksum>$

Which is a 22 Bytes record.

S_{Tmp1}, S_{Tmp2}: Values of the temperature sensors.
S_{Hdty}: Values of the humidity sensors.
$S_{Pressure}$: Values of the pressure sensors.
S_{Light}: Values of the light sensors.

S_{Camera}: Camera ON/ OFF flag.
A_1, A_2: Current values drawn by the Arduino and the FPGA respectively.
f_{com}: Frequency rate used by the communication part.
Mod_{com}: Modulation method used by the communication part.
Checksum: Ensuring the integrity of the data.

D. Number of analog channels being used:

No analog channels used.

E. If analog channels are being used, what are they being used for?

F. Number of discrete lines being used:

No discrete lines are used.

G. If discrete lines are being used what are they being used for?

H. Are there any on-board transmitters? If so, list the frequencies being used and the transmitted power.

Frequency located on the 70cm band (420 - 450 MHz). Real value not specified since the frequency will be varied depending on noise condition. The frequency used by the system in all cases will be allocated far enough from the frequencies used by the HASP balloon).

I. Other relevant downlink telemetry information.

The frequency will be the same as the transmitter. Transmitter and receiver will be operation on a half-duplex channel over the same frequency.

IV. Uplink Commanding Specifications:

A. Command uplink capability required: Yes No (circle one)

B. If so, will commands be uplinked in regular intervals: Yes No (circle one)

C. How many commands do you expect to uplink during the flight (can be an absolute number or a rate, i.e. *n commands per hour*)

22commands.

D. Provide a table of all of the commands that you will be uplinking to your payload

Command number	**Command byte 1**	**Command byte 2**	**Function**
1	0	0	Reset Arduino
2	0	F	Start Recording
3	F	0	Stop Recording
4	F	F	Record for 10 minutes
5	0	A	Stop 1st Tmp sensor
6	A	0	Start 1st Tmp sensor
7	0	B	Stop 2nd Tmp sensor
8	B	0	Start 2nd Tmp sensor
9	0	C	Stop humidity sensor
10	C	0	Start humidity sensor
11	0	D	Stop pressure sensor
12	D	0	Start pressure sensor

13	F	1	FPGA (communication) ON
14	F	2	FPGA (communciation) OFF
15	1	0	Modulation 1: OFDM
16	2	0	Modulation 2: QPSK
17	3	0	Modulation 3: BPSK
18	4	0	Modulation 4: ASK
19	5	0	Frequency 1
20	6	0	Frequency 2
21	7	0	Frequency 3
22	8	0	Frequency 4

E. Are there any on-board receivers? If so, list the frequencies being used.

The frequency will be the same as the transmitter. Transmitter and receiver will be operation on a half-duplex channel over the same frequency.

F. Other relevant uplink commanding information.

V. Integration and Logistics

A. Date and Time of your arrival for integration:

Monday, August 3rd at 4PM

B. Approximate amount of time required for integration:

We estimated 5h for payload integration in the facility

C. Name of the integration team leader:

Caterina Lazaro

D. Email address of the integration team leader:

clazarom@hawk.iit.edu

E. List **ALL** integration participants (first and last names) who will be present for integration with their email addresses:

We plan on having 4 integration participants:

- Caterina Lazaro (clazarom@hawk.iit.edu)
- Javier Garcia (jgarci42@hawk.iit.edu)

- Victor Arribas (varribas@hawk.iit.edu)
- - (Still to be decided)

F. Define a successful integration of your payload:

Successful integration of SCARLET HAWK III with HASP platform includes: Connecting power and uplink/downlink as well as attaching the payload to the platform. Having a working downlink for sensors, camera and communication data and an uplink for the required commands.

Confirming the functionality of individual sensors (the information is right) and camera (the SD card has the video recorded). The independent communication link will also be confirmed, verifying that we receive same downlink data in our ground station and the same uplink commands are sent to the payload.

Confirming the same functionality while undergoing thermal-vacuum testing. We expect to have some communication issues in this case: as the vacuum chamber is a closed metal isolated environment, our antennas may not be able to radiate through it or have some additional attenuation.

G. List all expected integration steps:

1. Connect the EDAC and DB9 to the SCARLET HAWK III payload.
2. Turn on payload power
3. Confirm successful downlink of sensor data
4. Confirm successful uplink of each serial command
5. Confirm successful communication system:
    - 5.a Downlink: sensor data received in our ground station
    - 5.b Uplink: commands sends to the payload station
    - 5.c Communication modes: check the communication system changes to the desired modulation and frequency
        - - Test modulation schemes: OFDM, QPSK, BPSK and ASK
        - - Test 4 carrier frequencies
6. Turn off the payload power
7. Close up the payload and check the mechanical interface between the base plate and the payload structure
8. Attach the payload base-plate to the HASP gondola structure
9. Turn on the payload power
10. Re-confirm successful downlink of sensor data
11. Re-confirm the successful uplink of each serial command
12. Re-confirm communication

H. List all checks that will determine a successful integration:

1. Nominal downlink and uplink communication.
2. Nominal power consumption.
3. Successful independent communication link.
4. Successful camera operation.

I. List any additional LSU personnel support needed for a successful integration other than directly related to the HASP integration (i.e. lifting, moving equipment, hotel information/arrangements, any special delivery needs…):

N/A

J. List any LSU supplied equipment that may be needed for a successful integration:

N/A