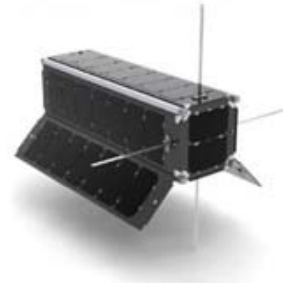




MYPOCKETQUB IQEA 442

an open source spacecraft payload



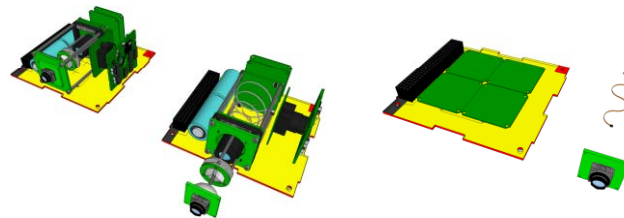
Anum Ali
 Alex Allan
 Radim Badsı
 Jordi Barrera
 Merlin Barschke
 Adam Brookes
 James Cooper
 Roger Duthie
 Jihan Farzana
 Nadeem Gabbani
 Abhinav Garg
 Toivo Hartikainen
 Matt Hearn
Nancy Hine

Alex Hocking
 Muthu Krishna
 Johan Marx
 Rob Morse
 Adam Moore
 Alex Narduzzo
 Dale Potts
 Paul Rernaud
 Trevor Seabrook
 Rupert Taylor
Johannes van der Horst
 Antoine Verhaeghe
 Camilla Weiss
 and others

Cranfield University
 Exmouth Community College
 Lancaster University
 Open University
 UCL / MSSL
 University of Bath
 University of Bristol
 University of Huddersfield
 University of Southampton
 University of Surrey
 and others

Michael Johnson
 spaceprojects@ukseds.org

UKube Payload
 Kick Off Meeting

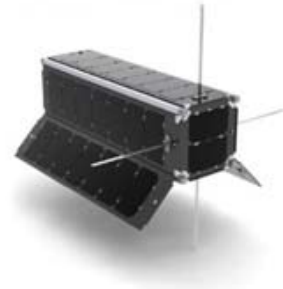


UK Space Agency, Swindon
 January 11, 2011



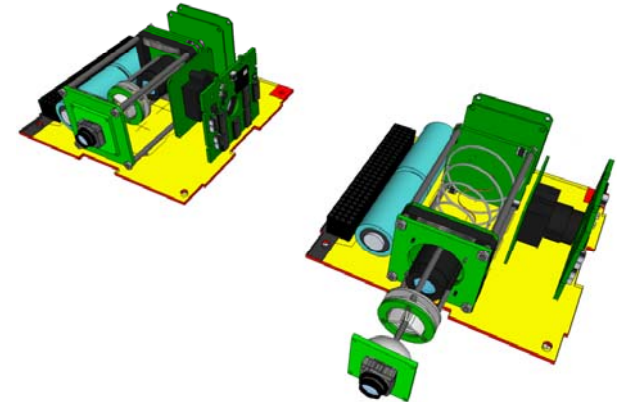


Brief overview

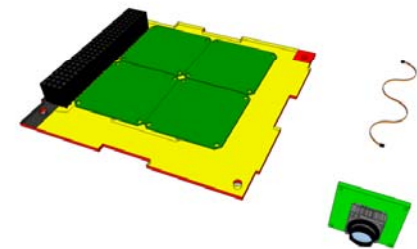


myPocketQub IQEA + vRadio + PocketPayloads:

- OpenSpace365
 - Arduino with sensors allowing 365 school pupils, university students or hobbyists to develop and fly virtual software payloads on-orbit for a day each for free
- OrbitView
 - imaging payload to capture 360 degree panoramas from multiple points on-orbit to allow anyone to 'look out of the window' of UKube1, Google Street View style
- Qubduino+
 - Arduino with Field Programmable Gate Array (FPGA) to space qualify the FPGA, test self repairing algorithms and host advanced virtual payloads
- SuperLab
 - physics experiment to characterise superconductor materials
- SuperSprite
 - satellite on a chip proof-of-concept with solar cells, energy storage, micro-controller and transceiver



Full height configuration



Low profile configuration

Views from UKube1 on:

Date: 31st December 2011 00:00Z

Altitude: 700km

Longitude: 0.0.0

Latitude: 0.0.0

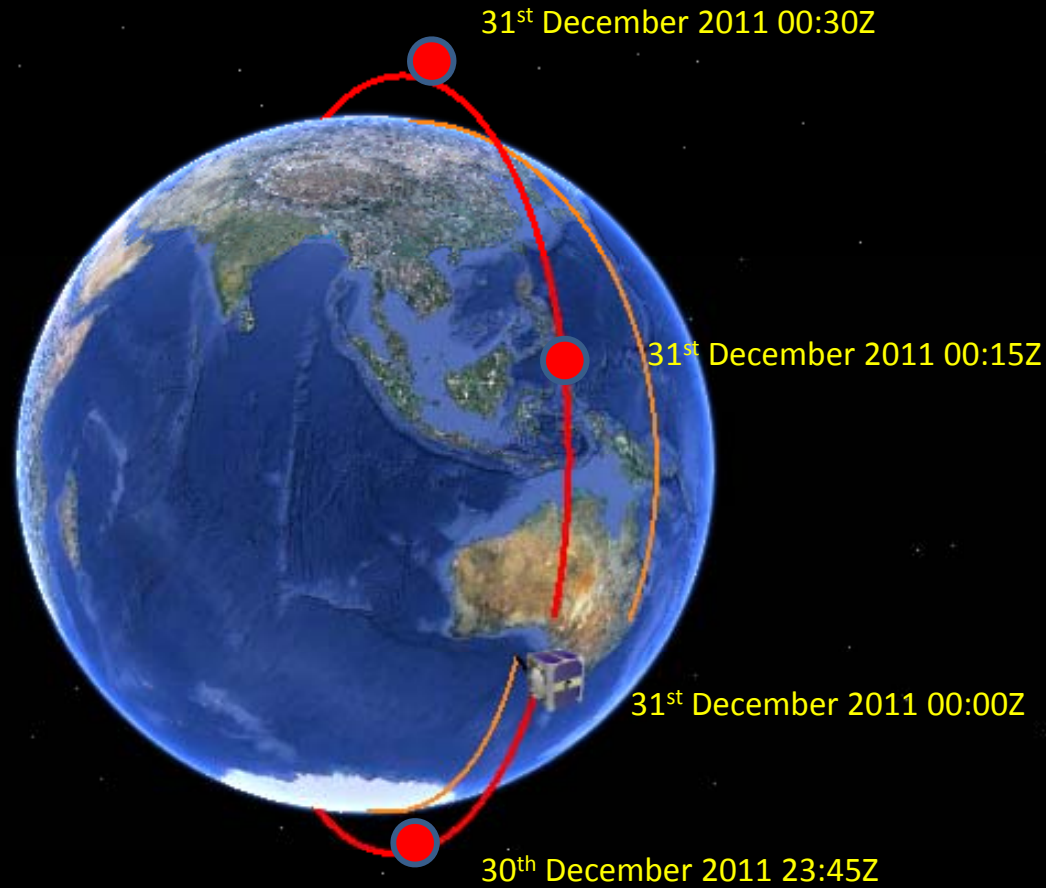
Satellite panorama – drag image:



Universe panorama – drag image:



NASA/courtesy of nasaimages.org



Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image IBCAO

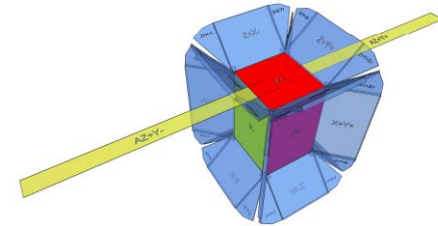
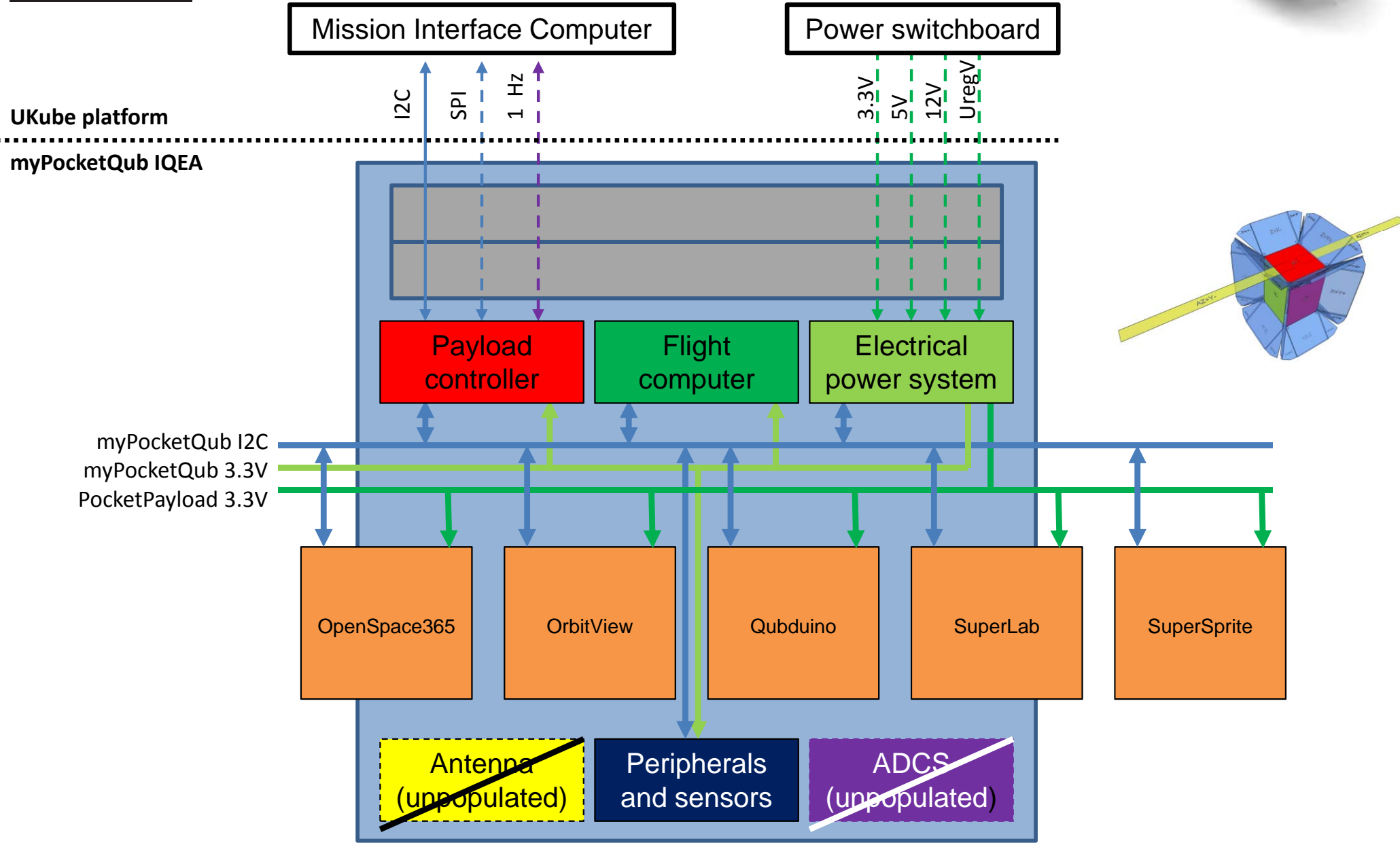
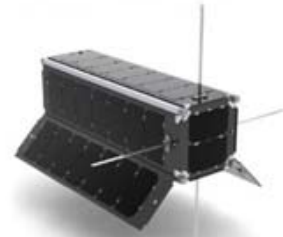


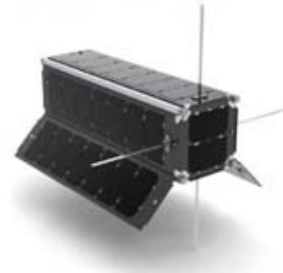
Click on the red dots to view space from a specific point on orbit on the date and time specified!

Mockup images: AeroSpace Corp, Google, NASA, Solenix



Functional architecture

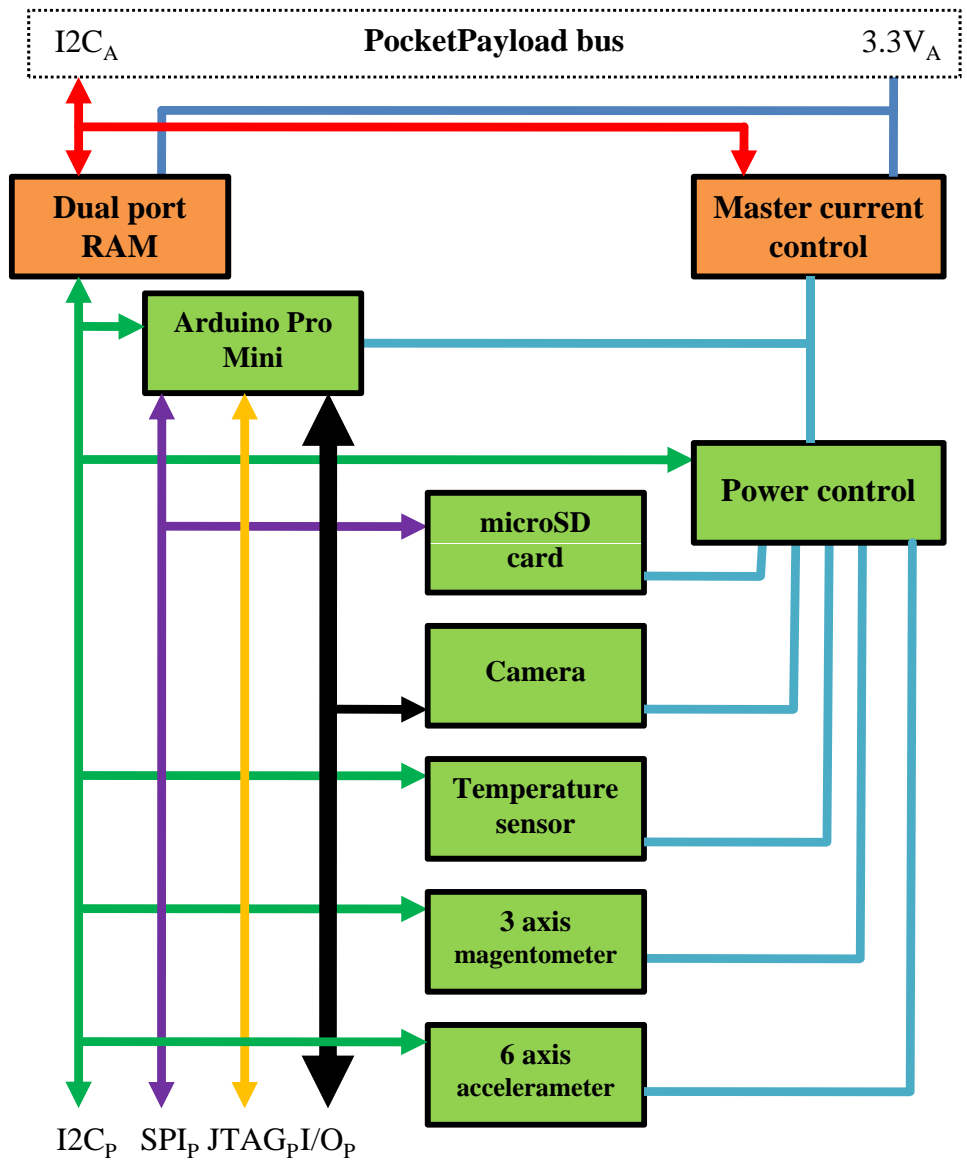




UKube platform
myPocketQub IQE

myPocket
myPocketQ
PocketPaylo

OpenSpace365



$I2C_P$ SPI_P $JTAG_P$ I/O_P

~~Antenna
(unpopulated)~~

Peripherals
and sensors

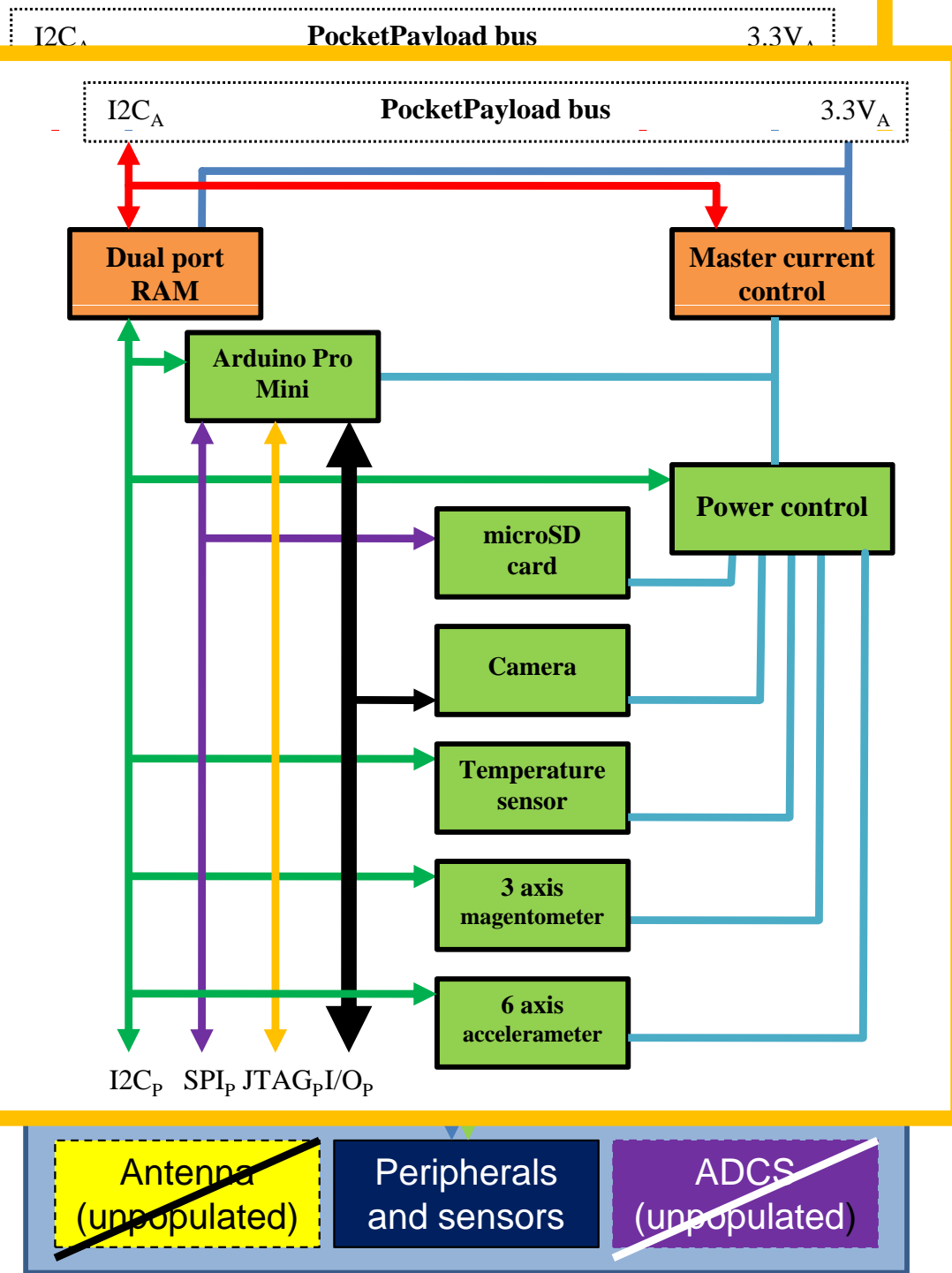
~~ADCS
(unpopulated)~~

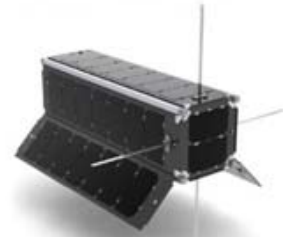


UKube platform
 myPocketQub IQE/

myPocket
 myPocketQ
 PocketPaylo

OrbitView

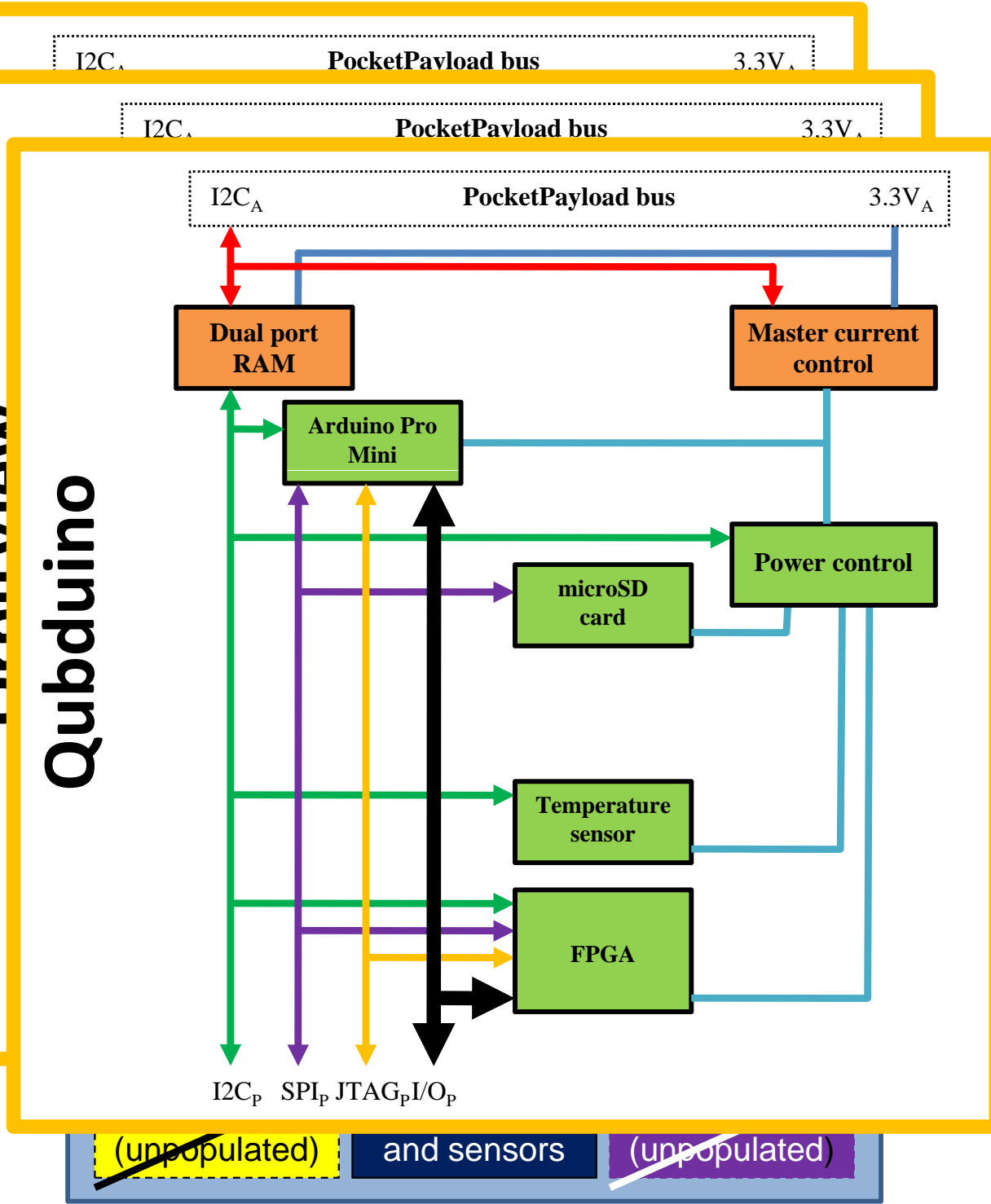


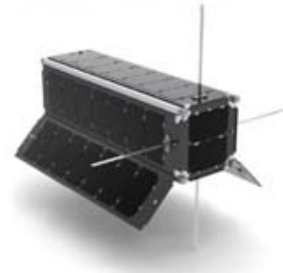


UKube platform
 myPocketQub IQE/

myPocket
 myPocketQ
 PocketPaylo

OranSnaco365
 OrbitView
 Qubduino

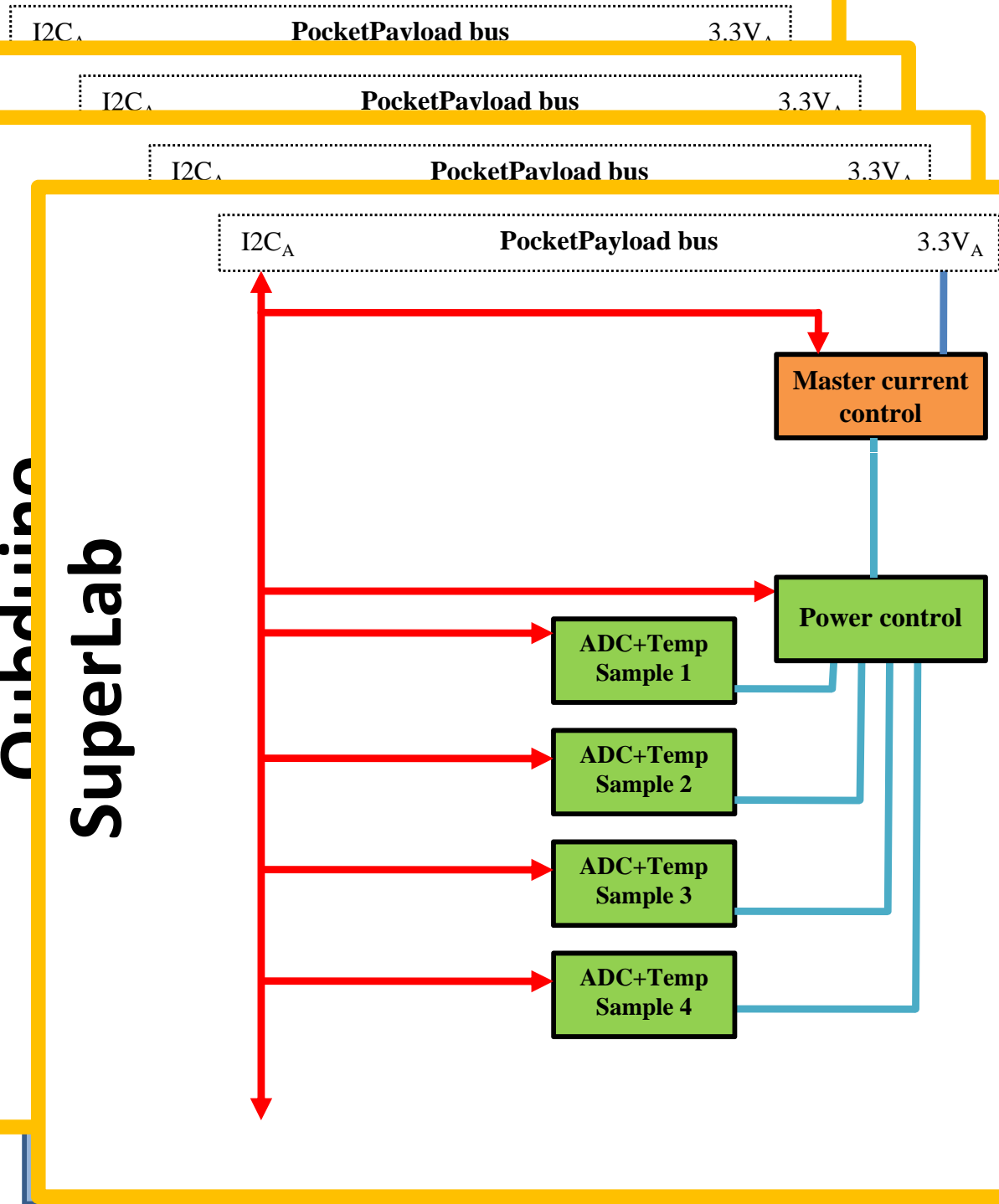


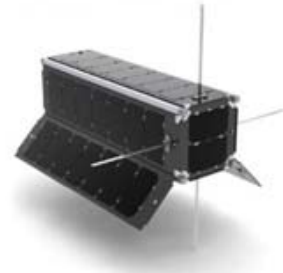


UKube platform
 myPocketQub IQE/

myPocket
 myPocketQ
 PocketPaylo

OnenSnaco365
 OrbitView
 Orbiting
 SuperLab





UKube platform
myPocketQub IQE/

myPocket
myPocketQ
PocketPaylo

OnenSnaco365

OrbitView

OrbitView

Superlab

SuperSprite

I2C_A PocketPayload bus 3.3V_A

I2C_A PocketPayload bus 3.3V_A

I2C_A PocketPayload bus 3.3V_A

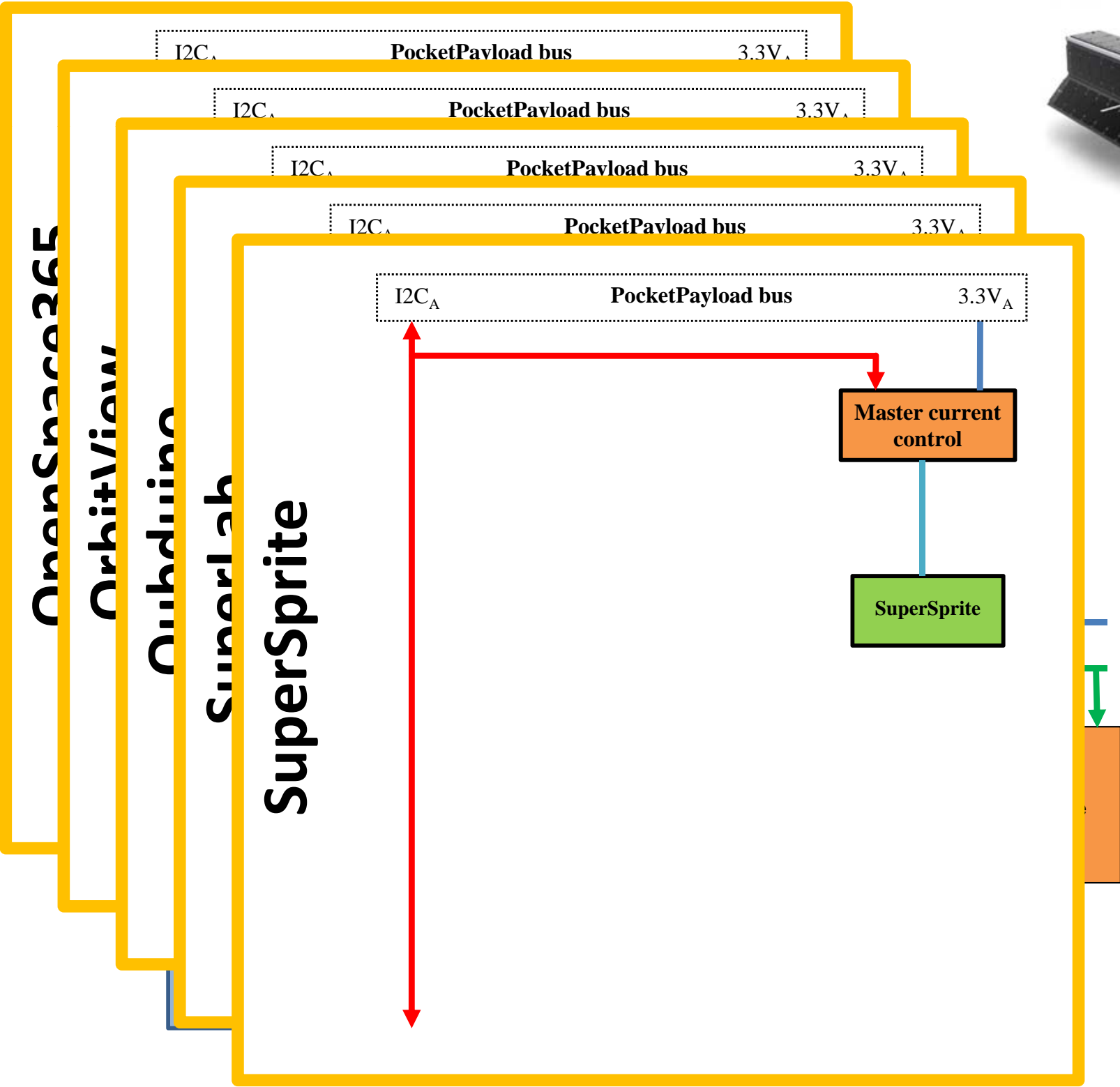
I2C_A PocketPayload bus 3.3V_A

I2C_A PocketPayload bus 3.3V_A

Master current control

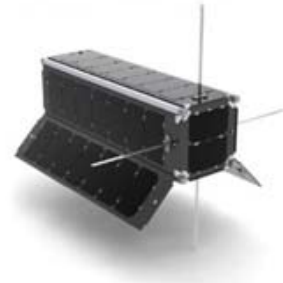
SuperSprite

...

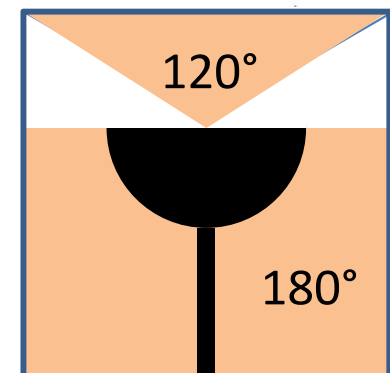
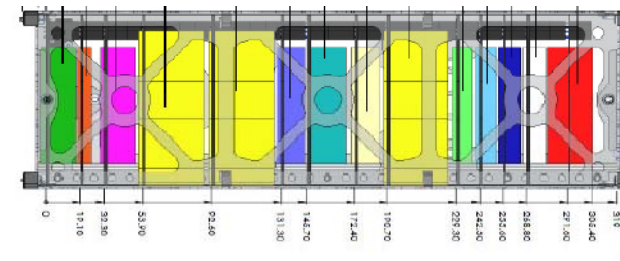
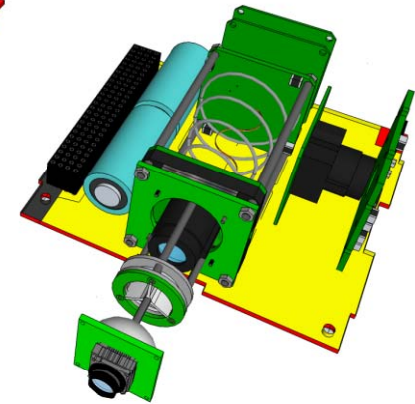
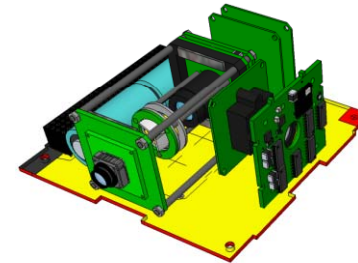




Interfaces: Full height

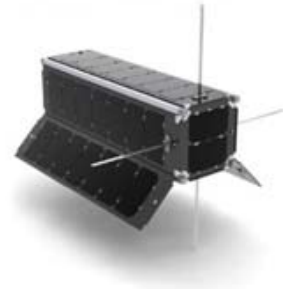


- Elements: Single integrated PC/104 card
- Mechanical interface: M3 pillars
- Electrical interface: CubeSatKit connector
- Structural/mounting interface:
 - Requires at least 20mm x 20mm aperture for panorama camera to deploy through
 - Requires 20mm x 20mm clear path to aperture, ideally from geometric centre of payload bay (can be displaced by up to 6mm in any direction from geometric centre) and can exit through +/- X (preferred) or +Y
 - Deployment through +Y gives satellite camera reduced field of view
 - Payload position preference: C > B > A
- OrbitView field of view:
 - Universe Camera: 120° (180° will be synthesised)
 - Satellite Camera: 180° one shot

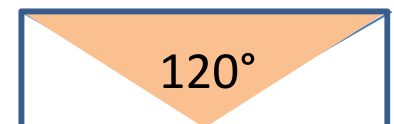
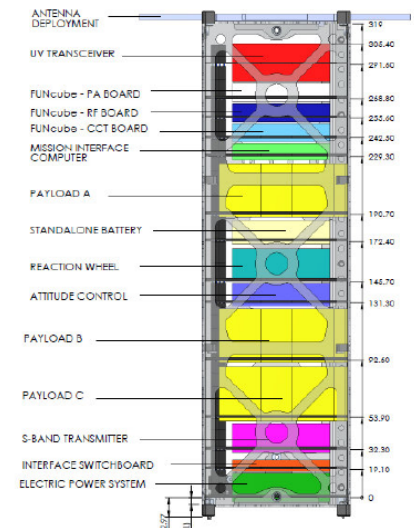
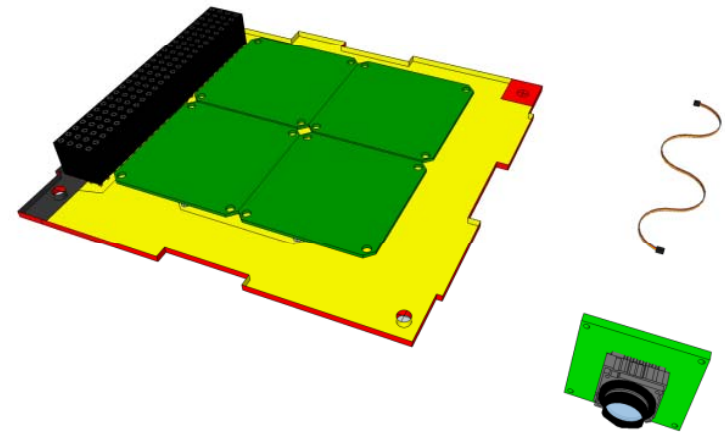




Interfaces: Low profile

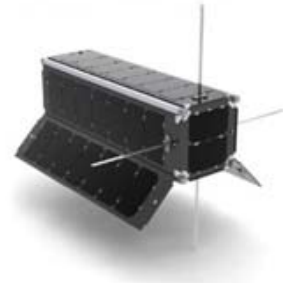


- Elements:
 - Low profile PC/104 card
 - Optional 20mm x 20mm sensor board
 - Optional wiring harness
- Mechanical interface:
 - PC/104 card: M3 pillars
 - Optional sensor board – as preferred by platform
 - Optional wiring harness – as preferred by platform
- Electrical interface:
 - PC/104 card: CubeSatKit connector
 - Optional sensor board – four wire (3.3V power + I2C)
- Structural/mounting interface:
 - at least 20mm x 20mm surface area on any face
 - path for four wire wiring harness
 - No payload position preference
 - Allows two additional PC/104 cards or eight 1PP / sixteen 0.5PP additional PocketPayloads to share the same UKube payload bay
- OrbitView field of view:
 - Universe Camera: 120° (180° will be synthesised)
 - Satellite Camera: Not applicable

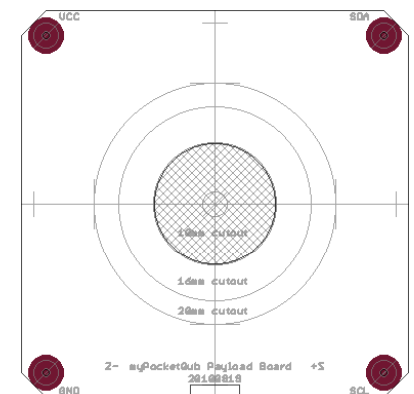
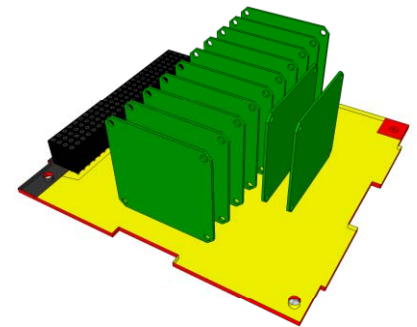
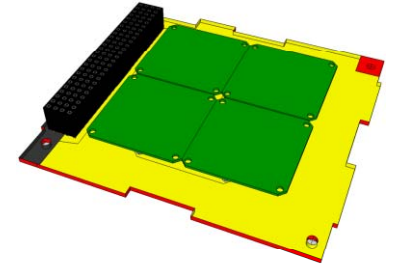




Interfaces: PocketPayloads



- Elements: 1PP 32mm x 32mm x 8mm card
- Mechanical interface:
 - Low profile configuration:
in plane 2 x 2 x 1PP array via M2 pillars
 - Full height configuration:
10PP and 2PP stack via M2 pillars and box
- Electrical interface:
 - PocketPayload 4 wire (I2C + 3.3V)
 - Optional unified ISP/JTAG/Spy-Bi-Wire connector
 - Optional custom inter-board connectors via slot
- Structural/mounting interface:
 - Not applicable as directly mounted on IQEA

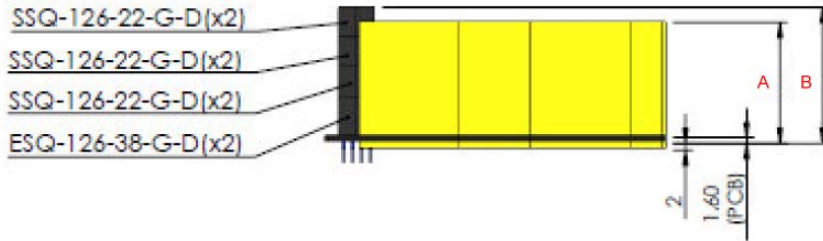




Payload mass/height budgets



Full height configuration



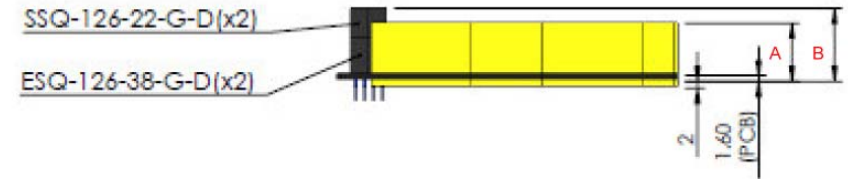
Height

Envelope height A :	34.00 mm
Connector height B :	38.18 mm

Mass

myPocketQub IQEA:	132g + 3xSSQ
UKube PC/vRadio:	8g
OrbitView (S+U cameras):	100g (E)
OpenSpace365:	8g
Qubduino+:	9g
SuperLab:	10g (E)
SuperSprite:	12g
TOTAL:	279g (E)
+ shielding/ballast if permitted	

Low profile configuration



Height

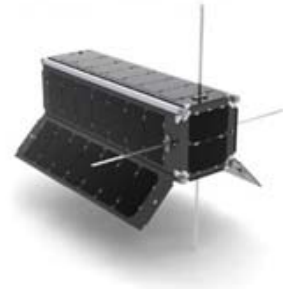
Envelope height A :	13.60 mm
Connector height B :	17.47 mm

Mass

myPocketQub IQEA:	132g + 1xSSQ
UKube PC/vRadio:	8g
OrbitView SB+W:	10g (E)
OpenSpace365:	8g
Qubduino+:	9g
SuperLab:	10g (E)
SuperSprite:	12g
TOTAL:	189g (E)
+ shielding if permitted	



Payload power budget

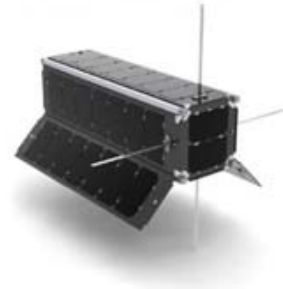


- current limiter set to enforce $<400\text{mW}$ over the sunlit period
- 1800mAh battery on board to buffer loads
- can operate during eclipse with no load on UKube if permitted
- payloads individually switchable

<i>Module</i>	<i>Standby (mW)</i>	<i>Typical (mW)</i>	<i>Peak (mW)</i>
myPocketQub IQEA	<6 (E)	49 (E)	102
PocketPayloads			
OpenSpace365	<4	50 (E)	110 (E)
OrbitView	<4	38 (E)	1688
Qubduino+	<5	330 (E)	1591
SuperLab	<1	<1	<1
SuperSprite	<1	<1	<1



Payload data budgets



- There are no real time data requirements and we can work with as much or as little bandwidth is available
- Payloads were originally designed for a 1200 baud data link and will not all be active simultaneously

<i>Module</i>	<i>Typical data upload (Kbit per day)</i>	<i>Typical data download (Kbit per day)</i>	<i>Onboard data storage</i>
myPocketQub IQEA	1	1	16 Kbit
OpenSpace365	1	} 512 shared per payload priority	16 Gbit
OrbitView	<0.5		16 Gbit
Qubduino	1	<0.1	16 Gbit
SuperLab	<0.1	<0.1	64 bit
SuperSprite	<0.1	0	16 Kbit
Total	<3.8 kbit per day	<514 Kbit per day	

more bandwidth can be utilised if available



Risks



- part time volunteer student team, however:
 - large pool to test and choose from
 - professional management
 - exam and high churn plans in place
- lack of priority access to test facilities, however:
 - multiple sources of supply (including international)
 - testing early and often
- a few single source components, however:
 - components already ordered or in hand
- risk of radio frequency interference, however:
 - happy to supply hardware for test to integrator
 - independent kill switch



Detailed schedule



WBS	Tasks	Task Lead	Start	End	Duration (Days)	Duration (Days)																											
						03 - Jan - 11	10 - Jan - 11	17 - Jan - 11	24 - Jan - 11	31 - Jan - 11	07 - Feb - 11	14 - Feb - 11	21 - Feb - 11	28 - Feb - 11	07 - Mar - 11	14 - Mar - 11	21 - Mar - 11	28 - Mar - 11	04 - Apr - 11	11 - Apr - 11	18 - Apr - 11	25 - Apr - 11	02 - May - 11	09 - May - 11	16 - May - 11	23 - May - 11	30 - May - 11	06 - Jun - 11	13 - Jun - 11	20 - Jun - 11	27 - Jun - 11	04 - Jul - 11	11 - Jul - 11
1	Payload Development, Integration and Test	Project Lead	11.01.2011	11.07.2011	182	[Gantt bar]																											
1.1	Production of documentation	Engineering lead	11.01.2011	15.01.2011	7	[Gantt bar]																											
1.2	myPocketQub IQEA development	Engineering lead	15.01.2011	17.03.2011	62	[Gantt bar]																											
1.3	UKube payload interface module development	Engineering lead	15.01.2011	17.03.2011	62	[Gantt bar]																											
1.4	Openspace365 development	Openspace365 lead	15.01.2011	17.03.2011	62	[Gantt bar]																											
	Non critical components ordered/lead time		01.02.2011	14.02.2011	14	[Gantt bar]																											
	Assembly		01.03.2011	17.03.2011	17	[Gantt bar]																											
1.5	OrbitView development	OrbitView lead	15.01.2011	17.03.2011	62	[Gantt bar]																											
	Critical Component Ordered/lead time: Mirror		15.01.2011	04.02.2011	21	[Gantt bar]																											
	Non critical components ordered		01.02.2011	14.02.2011	14	[Gantt bar]																											
	Assembly		01.03.2011	17.03.2011	17	[Gantt bar]																											
1.6	Qubduino development	Qubduino lead	15.01.2011	17.03.2011	62	[Gantt bar]																											
	Critical Component Ordered/lead time: FPGA		15.01.2011	04.02.2011	21	[Gantt bar]																											
	Non critical components ordered		01.02.2011	14.02.2011	14	[Gantt bar]																											
	Assembly		01.03.2011	17.03.2011	17	[Gantt bar]																											
1.7	SuperLab development	SuperLab lead	15.01.2011	17.03.2011	62	[Gantt bar]																											
	Critical Component collected: superconductors		04.01.2011	04.01.2011	1	[Gantt bar]																											
	Non critical components ordered		01.02.2011	14.02.2011	14	[Gantt bar]																											
	Assembly		01.03.2011	17.03.2011	17	[Gantt bar]																											
1.8	SuperSprite development	SuperSprite lead	15.01.2011	17.03.2011	62	[Gantt bar]																											
	Critical Component received: Sprite Chip		01.12.2010	01.12.2010	1	[Gantt bar]																											
	Non critical components ordered		01.02.2011	14.02.2011	14	[Gantt bar]																											
	Assembly		01.03.2011	17.03.2011	17	[Gantt bar]																											
1.9	Assembly and Integration: dependent on 1.1 to 1.8	Engineering lead	18.03.2011	31.03.2011	14	[Gantt bar]																											
1.10	Verification and Testing: dependent on 1.1 to 1.9	Validation/QA lead	01.04.2011	13.06.2011	74	[Gantt bar]																											
1.11	Post Acceptance Review changes	Validation/QA lead	14.06.2011	11.07.2011	28	[Gantt bar]																											
Meetings, Reviews, Deadlines																																	
	Payload Kick off		11.01.2011	11.01.2011	1	[Gantt bar]																											
	March - choice of payload		March			[Gantt bar]																											
	Deliver featured CAD model of payload for virtual fit test		01.04.2011	01.04.2011	1	[Gantt bar]																											
	System Critical Design Review		13.04.2011	13.04.2011	1	[Gantt bar]																											
	Payload Acceptance Review		14.06.2011	14.06.2011	1	[Gantt bar]																											
	Payload Delivery Review		11.07.2011	11.07.2011	1	[Gantt bar]																											



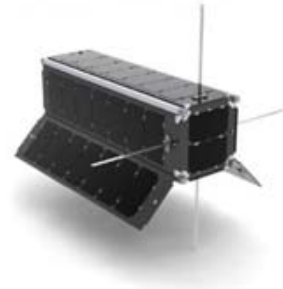
Maturity



	Software			
	Hardware	Space	Ground	Web
myPocketQub IQEA:				
PocketPayload adaptor	+++	+++	++	-
Virtual radio/payload adaptor	++	+	<i>i</i>	-
<i>Low profile configuration only:</i>				
Sensor board	+	-	-	-
Sensor wiring harness	+	-	-	-
PocketPayloads:				
OrbitView	++	++	+++	+
OpenSpace365	+++	+++	+++	+
Qubduino	+++	+++	+++	-
SuperLab	+++	+++	+++	-
SuperSprite	+++	+++	+++	-
Key: <i>i</i> awaiting information + specified ++ designed +++ bench ++++ system +++++ flow				



Assumptions



- we might be permitted to use our board battery to power myPocketQub 442 during eclipse so we can image one or more complete orbits
- we will be told how eclipse will be signalled
- we will be permitted to discuss the project in public soon (making clear that we might not be selected) so
 - we can put myPocketQub 442 on the web to start simulating months of real operations
 - we can start actively seeking virtual payloads at public events such as European CubeSat Workshop (January), UKSEDS conference (February), Makerfaire UK (March), Annual CubeSat Developers Workshop (April), etc.
- we will be given the specifications for the ground control web interface soon



Q&A session



Thank you for the opportunity!

Michael Johnson
spaceprojects@ukseds.org