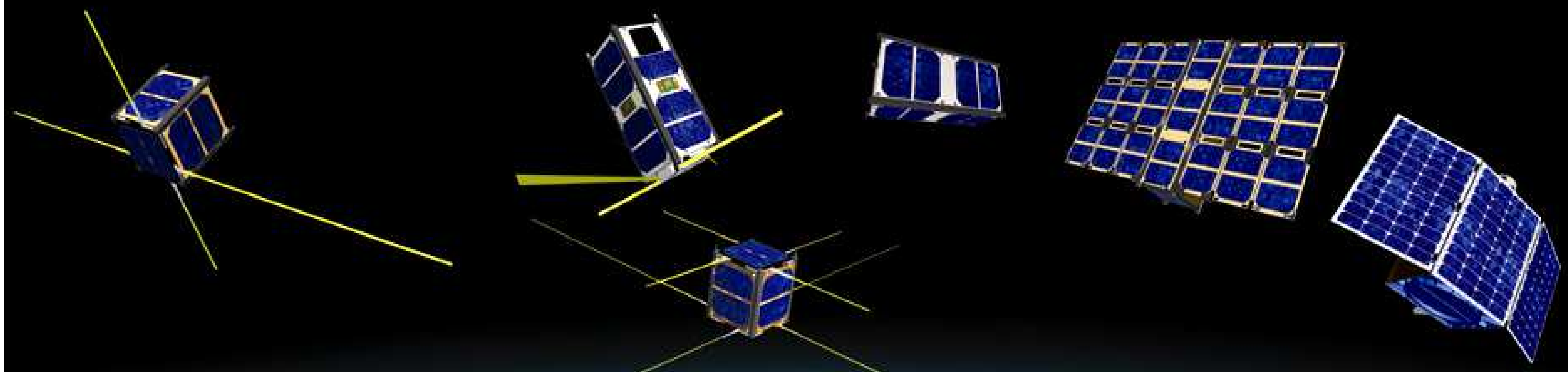
Preliminary CubeSat Reference Design

Things to consider for the design of your CubeSat Platform

QB50 Workshop



Jeroen Rotteveel – ISIS – Innovative Solutions In Space

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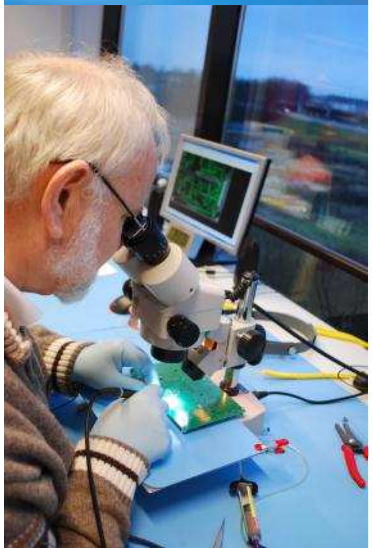
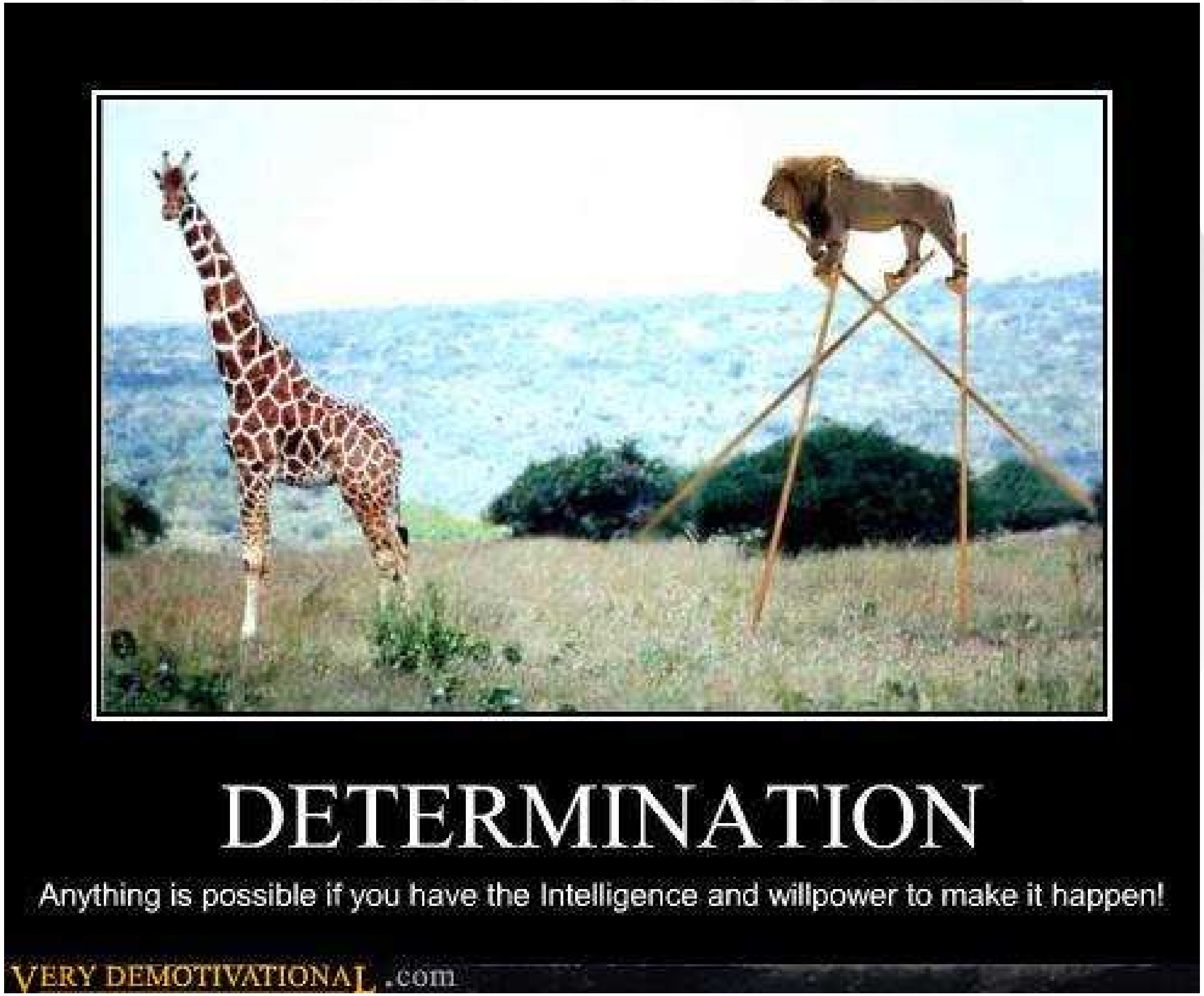



- General Overview of the spacecraft
- Dependency on payloads
- Preliminary Budgets
  - Mass
  - Power
- De-risk
  - Make/buy
  - Train your team
- Conclusions

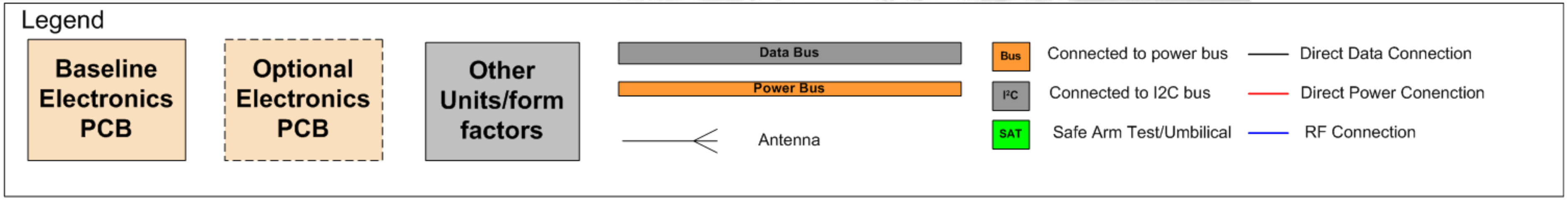
QB50 science package in a 2U? Really?



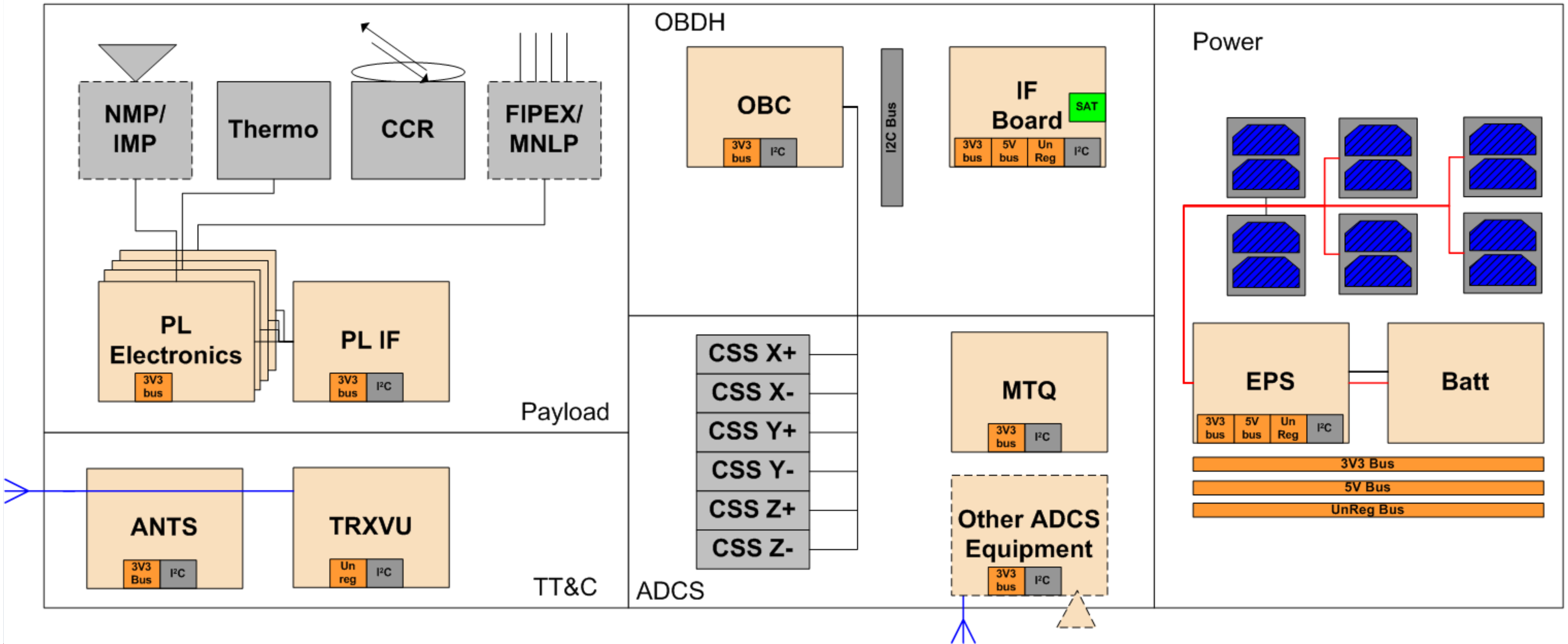
Disclaimer:

Very preliminary results, based on draft RFP + iteration using the latest information from the QB50 consortium team

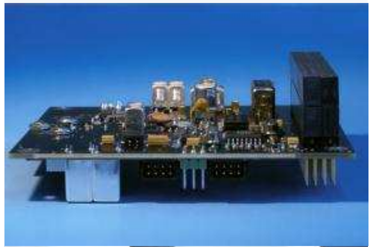
Satellite System Building Blocks

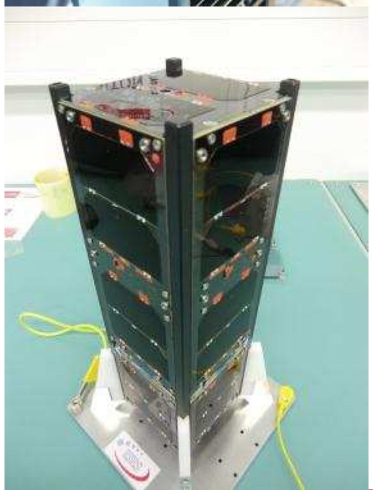


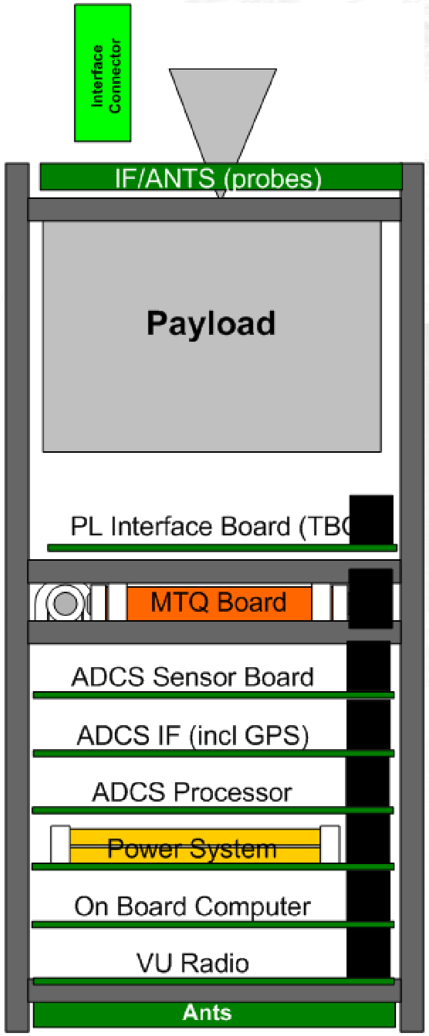
Satellite System Block Diagram



QB50 Spacecraft – A tight fit







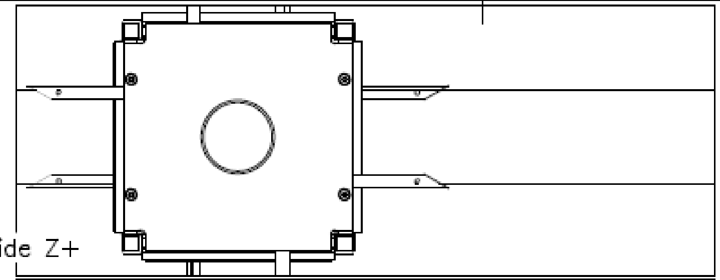
- 2U CubeSat
- Large Payload Volume
- PC/104 CSKB boards take up a lot of space
- Need of an umbillical connector
- Where to put your own payload?
- No room for redundancy

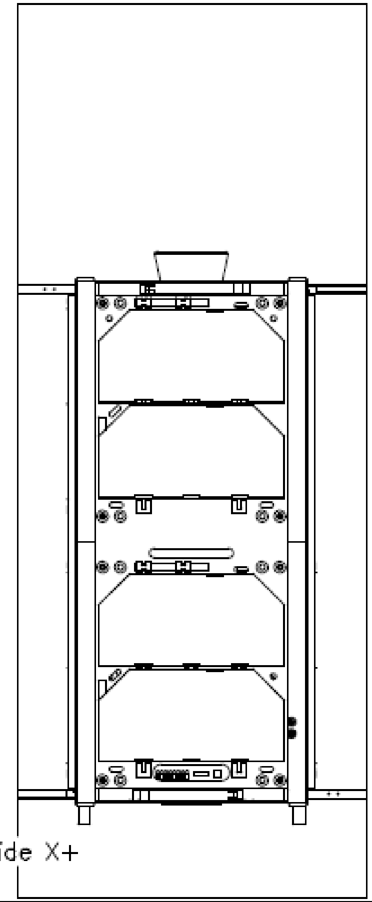
Payload Dependencies

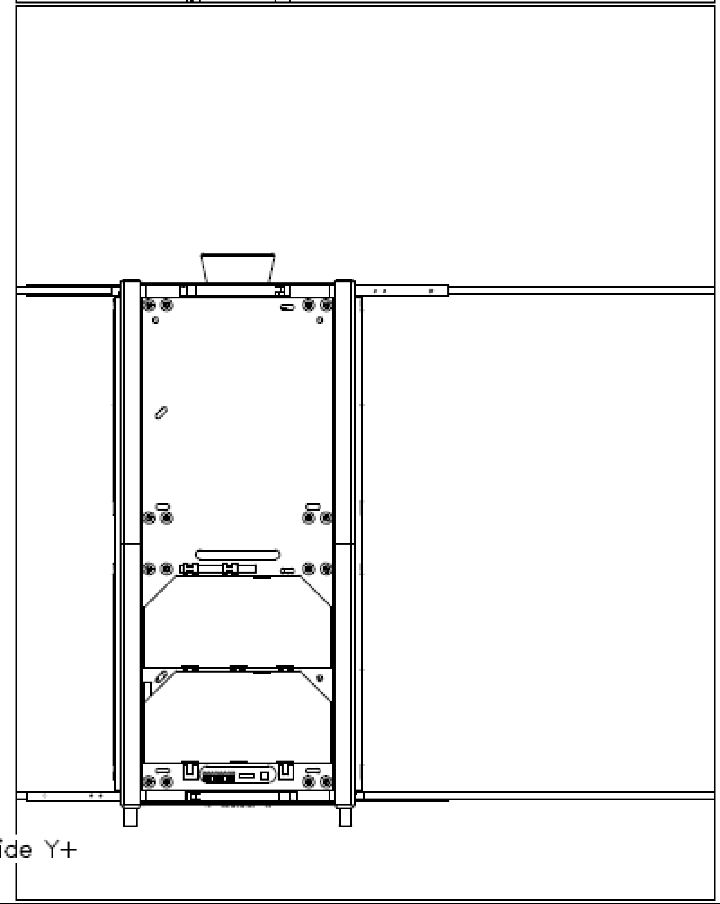
- Power Budget
  - Peak power: scales batteries
  - Orbit Average Power: scales power generation
- Mass and volume: constrains design flexibility
- Attitude Control
  - Pointing requirements
  - Disturbances from deployables
- CDHS & Comms
  - Lot of data generated, how to get it down?

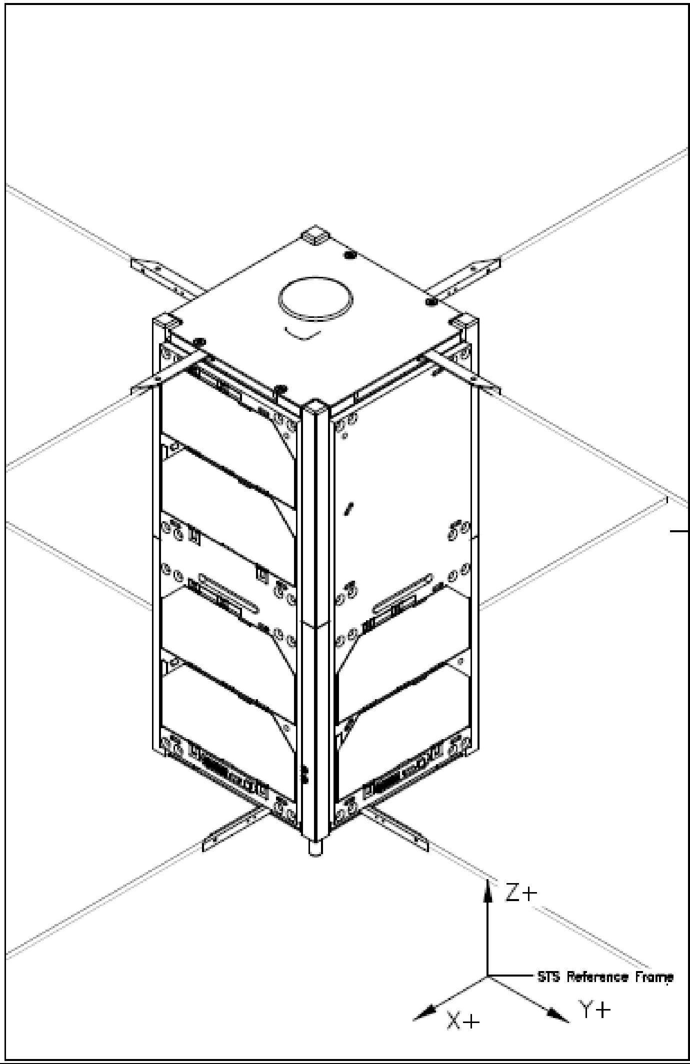
- Scaling down payload suites helps the reference design a lot. Makes 2-U Bus feasible

Rev	Description	Date	Initials
x	xxx	xxx	GL









ISIS										
	Project name	STS – ISIS CubeSat Structures	Scale	50%		By	Date	Material	N.A.	Notes:
	Drawing name	2U QB50 SSC draft	Size	A3	Drawn	GL	31 Jan 2012	Surface treatment	N.A.	
	Drawing number	ISIS.STS.2U.xxx	Rev	–	Checked	GL	xxx	Dimensions	[mm]	
			Sheets	1/1	Approved	JELS	xxx	Tolerance	±0.1 [mm] (Unless stated otherwise)	

Mass Budget

Structure			Mass	Margin	Total
	2U Structure	1	200	5%	210
	Top Solar Panel	1	25	5%	26,3
	Bottom Solar Panel	1	50	5%	52,5
	Earth panel	1	25	5%	26,3
	Side Solar Panels	3	100	5%	315
Power					
	3U EPS (incl Bat)	1	200	5%	210
OBDH					
	OBC	1	50	5%	52,5
RF					
	VHF/UHF Transceiver	1	80	5%	84
	TTC AntS	1	90	5%	94,5
ADCS					
	Sensors	1	100	5%	105
	Actuators	1	200	5%	210
Payload					
	Payload Package	1	500	10%	550
Misc					
	Interface Board	1	50	5%	52,5
	Payload Interface	1	25	5%	26,3
	Harnessing, cabling, fastners	1	50	10%	55
	Thermal Control	1	25	5%	26,3
Total Mass					2096

Power Budget

Load Characteristics:	Orbit Average	Peak Sub-system		Average Sub-system	
Component:	Duty Factor:	Power:	Units:	Power:	Units:
EPS	100%	0,25	watts	0,25	watts
OBC	100%	0,26	watts	0,26	watts
Primary Transceiver (Rx Only)	99%	0,16	watts	0,17	watts
Primary Transceiver (Downlink)	1%	1,26	watts	0,01	watts
Ants and other standby power	100%	0,01	watts	0,01	watts
ADCS	50%	0,25	watts	0,13	watts
PL module	50%	0,50	watts	0,28	watts
Total excl efficiency losses				1,11	watts
Total incl efficiency losses	(15% regulator and 15% battery charge losses)			**1,68**	**watts**
Power Input					
Sunlit Average Power (at solar panels)	4	W			
Orbit Average Power (at solar panels)	2,5	W			
Orbit Average Power (at bus)	**1,81**	W (estimate)		**1.81>1.68**	
Average charge available in Sunlight	2,32	W			
Time to rechargeg battery	**53**	mins		**sunlight period ~60 minutes**	

De-risk: Make or Buy

- Several parties announced QB50 compliant buses and subsystems
- Often collaborations between multiple parties
- When budgetting for purchasing cost, be aware of custom requirements
- Possible advantages in 'block buys'

De-risk: Experienced team

- A well trained team is essential
- Access to experienced people is very valuable
- Learn from the other teams
- Share knowledge and experience

Conclusions

- Based on the **preliminary** requirements and constraints it seems feasible to design and built a compliant mission largely based on OTS systems.
- The **preliminary** reference design shows that fitting all this functionality into a 2-Unit CubeSat is a real technical challenge in terms of mass, power, volume, etc.
- De-risk by training your team and possibly relay on providers of OTS systems
- Do not underestimate the cost of such platforms in terms of manpower, HW, SW and testing

- Make sure you keep up to date on the latest developments for QB50 compliant systems: e.g. Through www.CubeSatShop.com/QB50

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