mARZ Sat

An Arizona Space Grant Consortium Program

Helen Reed
Melissa Wallace
Tim Campbell

Program Goals

- Develop a top-level design for a student built Mars microsatellite
- Build a geographically disparate team
  - Arizona State University
  - Embry-Riddle Aeronautical University
  - Northern Arizona University
  - University of Arizona
- Student education

Geographically Disparate, Or: How I learned to stop worrying and love the telecon

- Inter & Intra team communication a top priority from the start
  - weekly program telecons
  - weekly management telecons
  - monthly all-hands meetings
  - weekly to daily subsystem telecons & meetings

Geographically Disparate con't

- Design practices adopted
  - Well defined communication channels and flow of information
  - Frequent reviews
  - Tight interface specifications
  - Rigorous documentation requirements and configuration management procedures
  - Use of a central file server
  - Use of mailing lists

mARZ Sat Mission

- Capture high resolution images of a set of predefined activities performed by Telesat
- Transfer those images back to Earth via Telesat

Program Requirements

- Budget not to exceed 20M FY'03 dollars
- 2008 delivery
- 20kg mass and a target volume of 8 L.
- Launch, transit, & insertion attached to Telesat
- After release, autonomously maintain station near Telesat for 3 months
- Capture images of all scheduled imaging events and relay images back to Telesat when scheduled

mARZSat Subsystems

- Attitude, Orbit, Determination, and Control (AODC)
- Structures, Mechanisms, Thermal, and Radiation(SMTR
- Payload (PAY)
- Command and Data Handling (C&DH)
- Electrical and Power Systems (EPS)
- Communication (COMM)

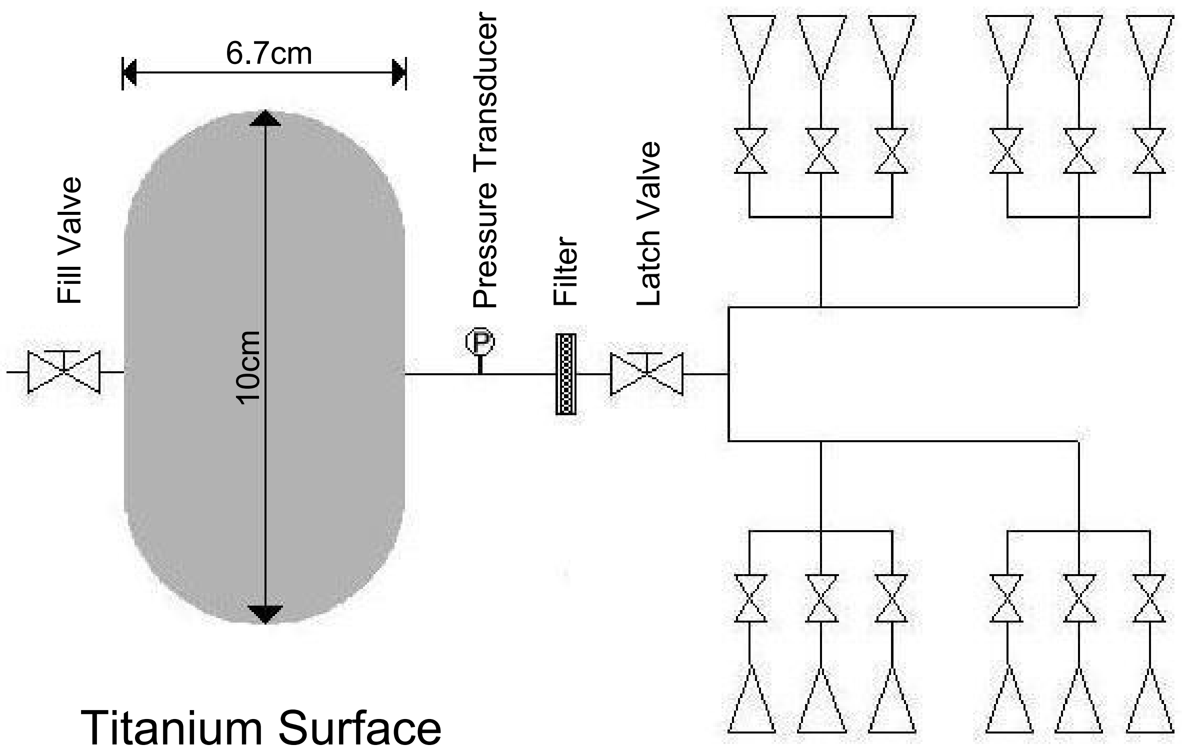
Goals for Subsystems

- Emphasis on Trades
  - Trade Drivers
- Utilizing micro-technology
  - Technology Readiness Levels (TRL)
- Interaction with industry
  - NASA Jet Propulsion Laboratory
  - Spectrum Astro

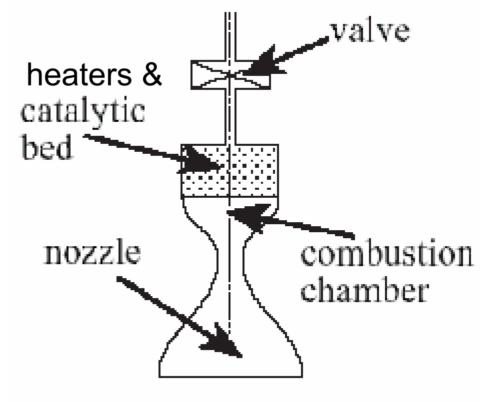
Examples of Trades and Design Work

	Pro's	Con's
Passive	▪ simple ▪ minimal requirements	▪ not capable of 1° accuracy
Pure Spin Stabilization	▪ resists disturbance torques ▪ <1° accuracy	▪ more propellant to reorient ▪ precession and wobble
Dual Spin Stabilization	▪ resists disturbance torques ▪ <1° accuracy, ▪ camera is not rotating	▪ same as above ▪ bearings on de-spun section may fail
Reaction Wheels	▪ <1° accuracy ▪ minimal propellant	▪ large volume, mass, and power requirements
Three-Axis Stabilization	▪ **easily maneuverable** ▪**<1° accuracy**	▪ **propellant limits mission duration**

Examples of Trades and Design Work



Titanium Surface Tension Propellant Tank



Examples of Trades and Design Work

2607cm³ → 3602 cm³

Material: Aluminum 6061-T6

	Pro	Con
Aluminum 6061-T6	Inexpensive High Availability Moderate Temperature Range Easily Machined	Lower Strength High Density Low Melting Point
Titanium	High Temperature Range High Strength Low Density High Melting Point	Hard to Machine Expensive Less available

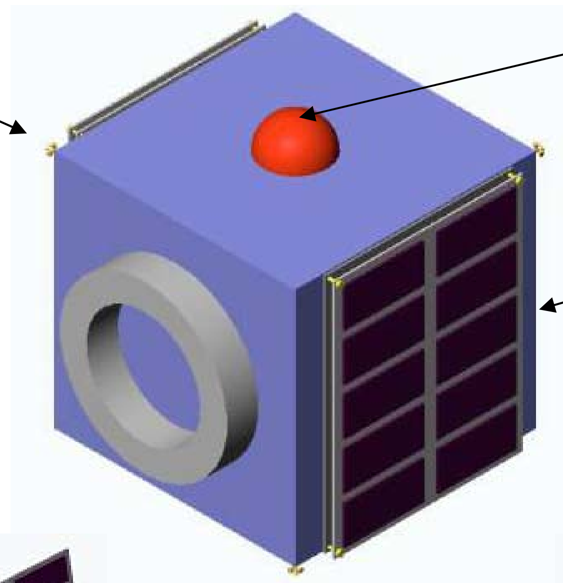
Examples of Trades and Design Work

Micro Thrusters

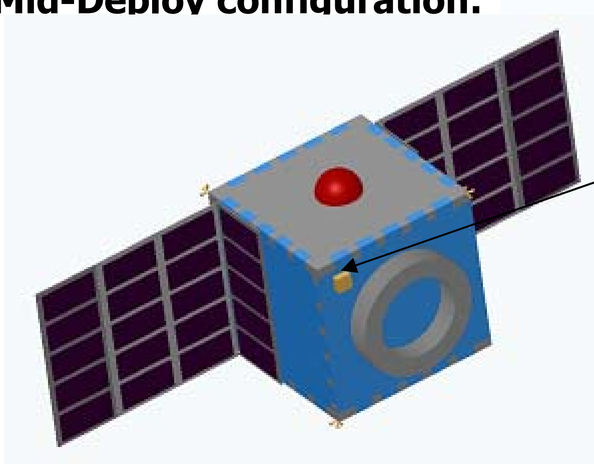
Launch configuration:

Antenni

Solar Panels (2)

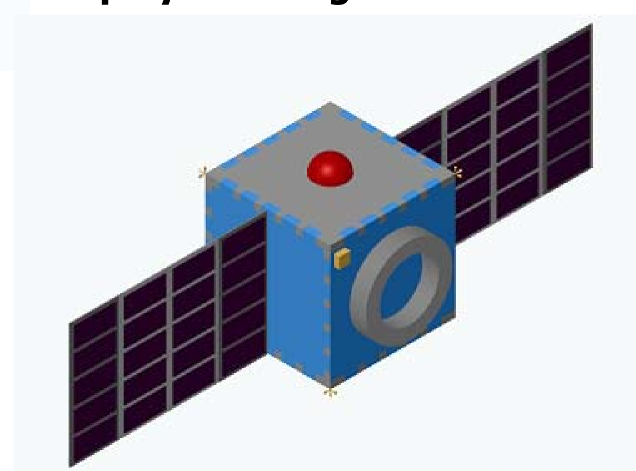


Mid-Deploy configuration:

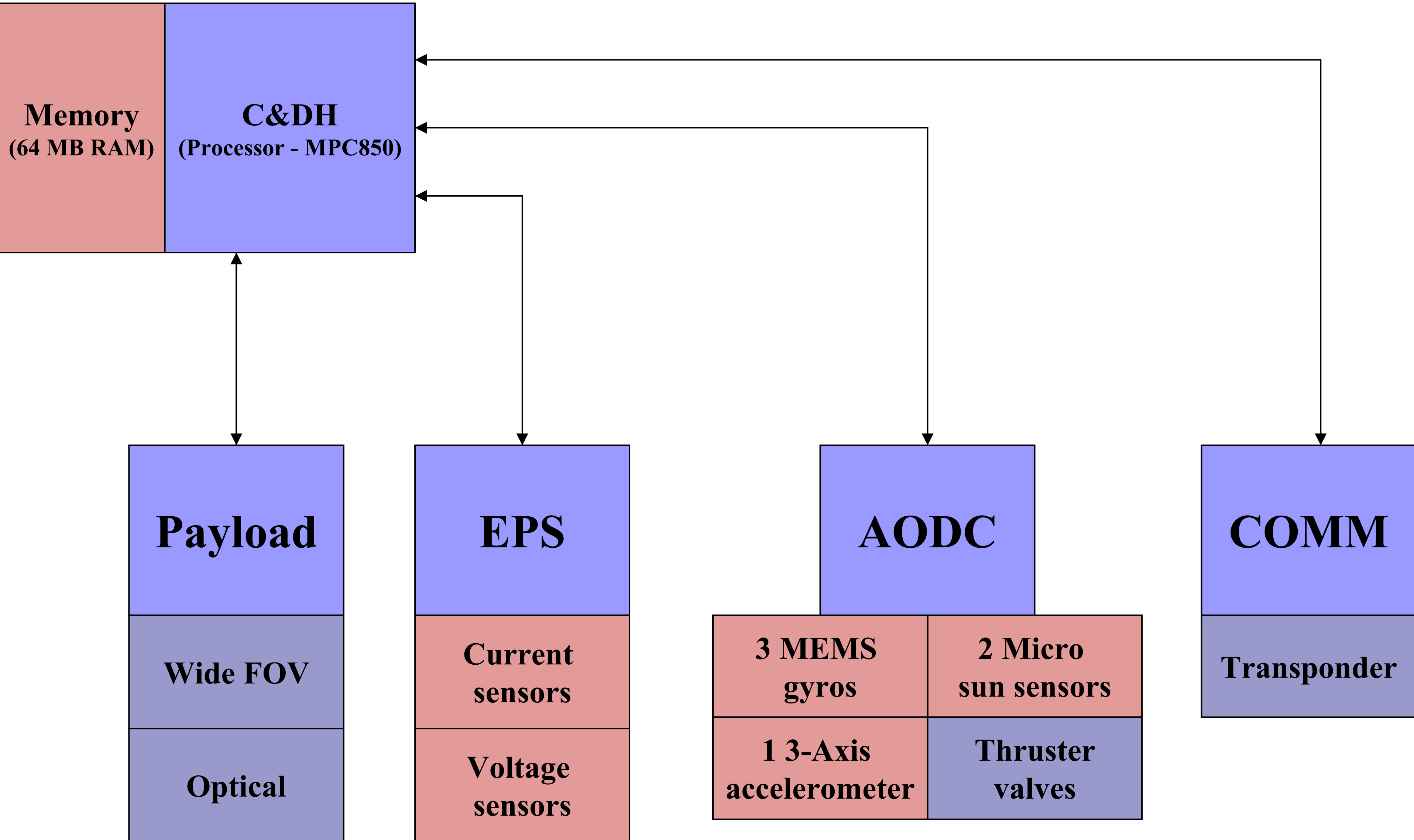


Sun
Sensor

Deployed configuration:

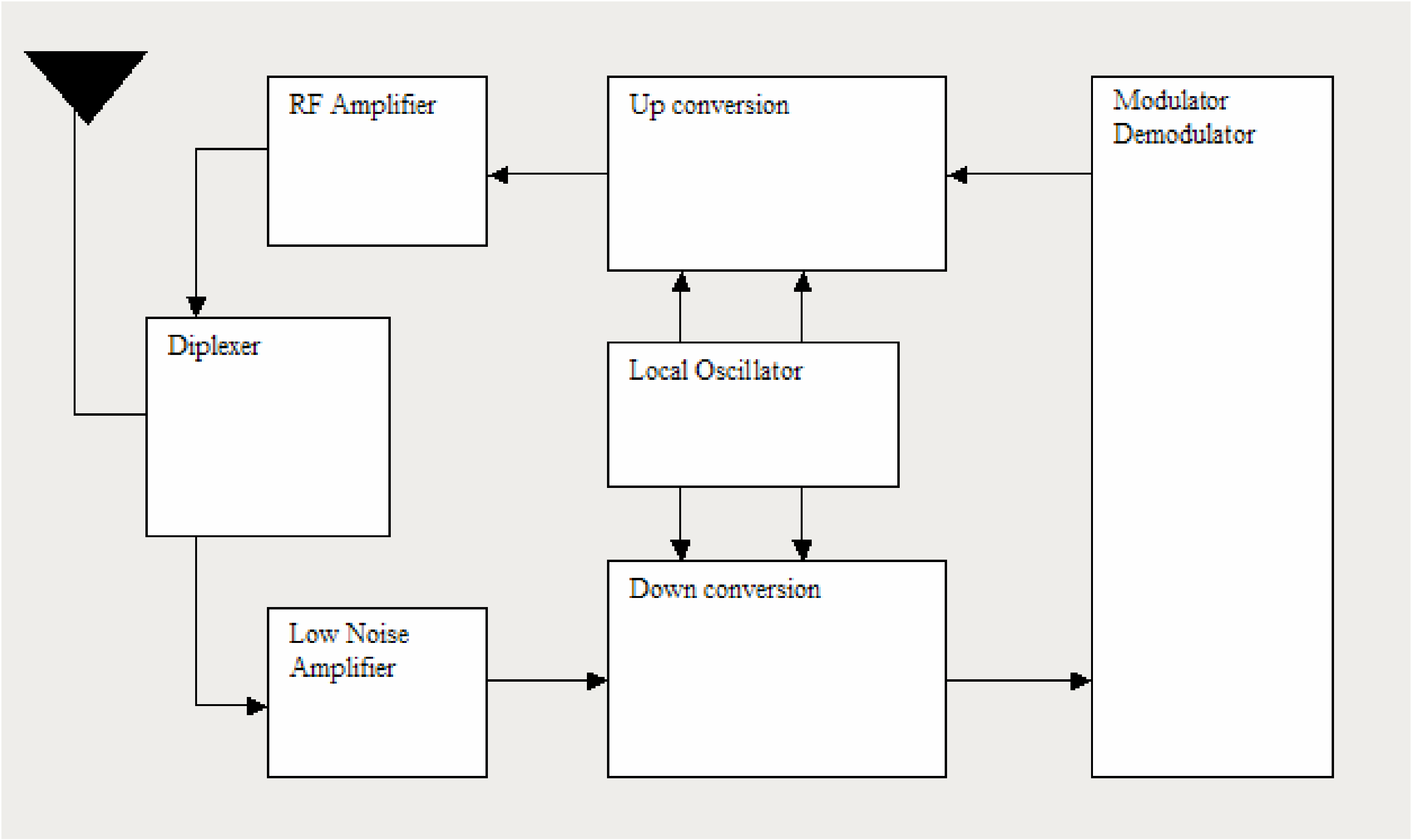


Examples of Trades and Design Work

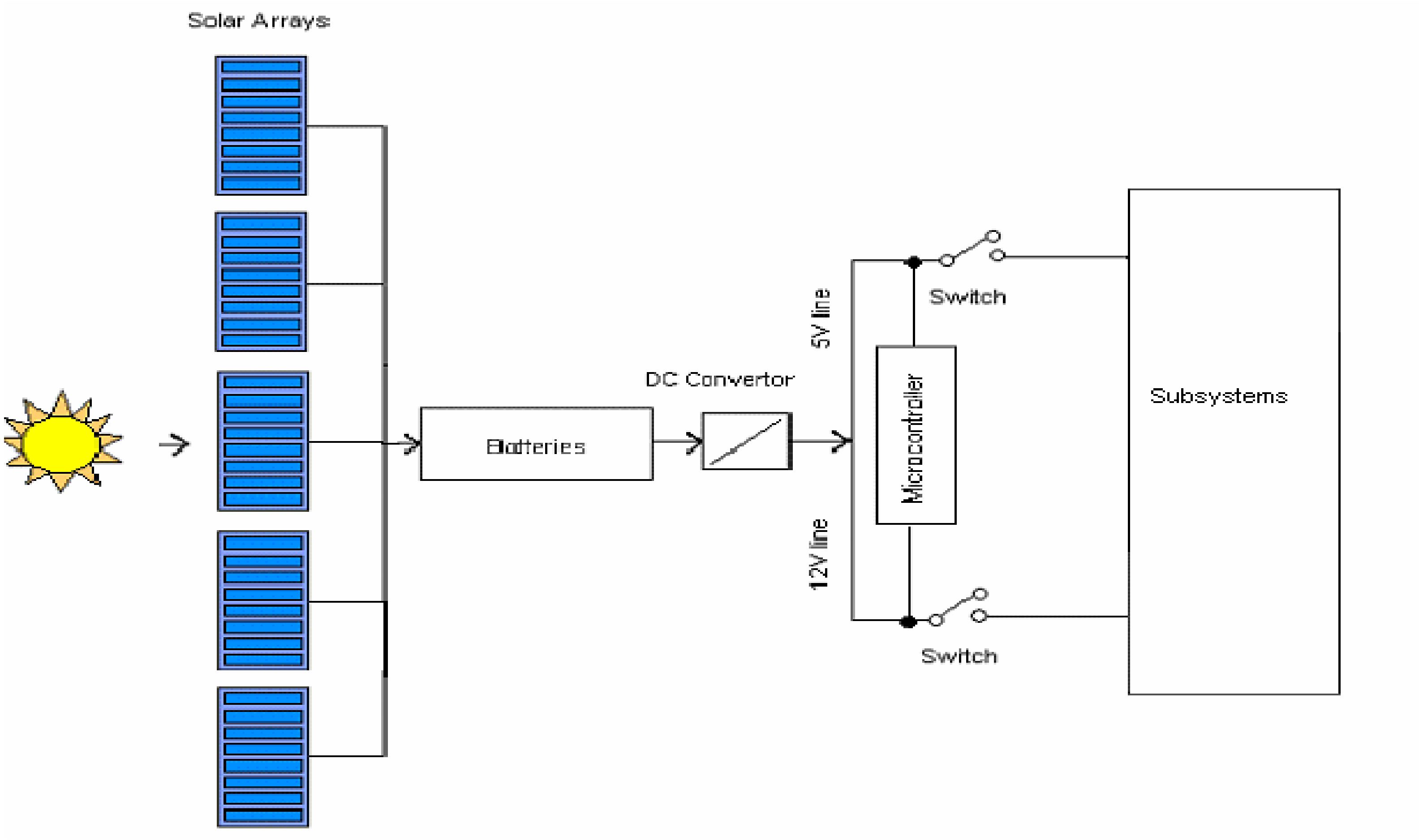


Examples of Trades and Design Work

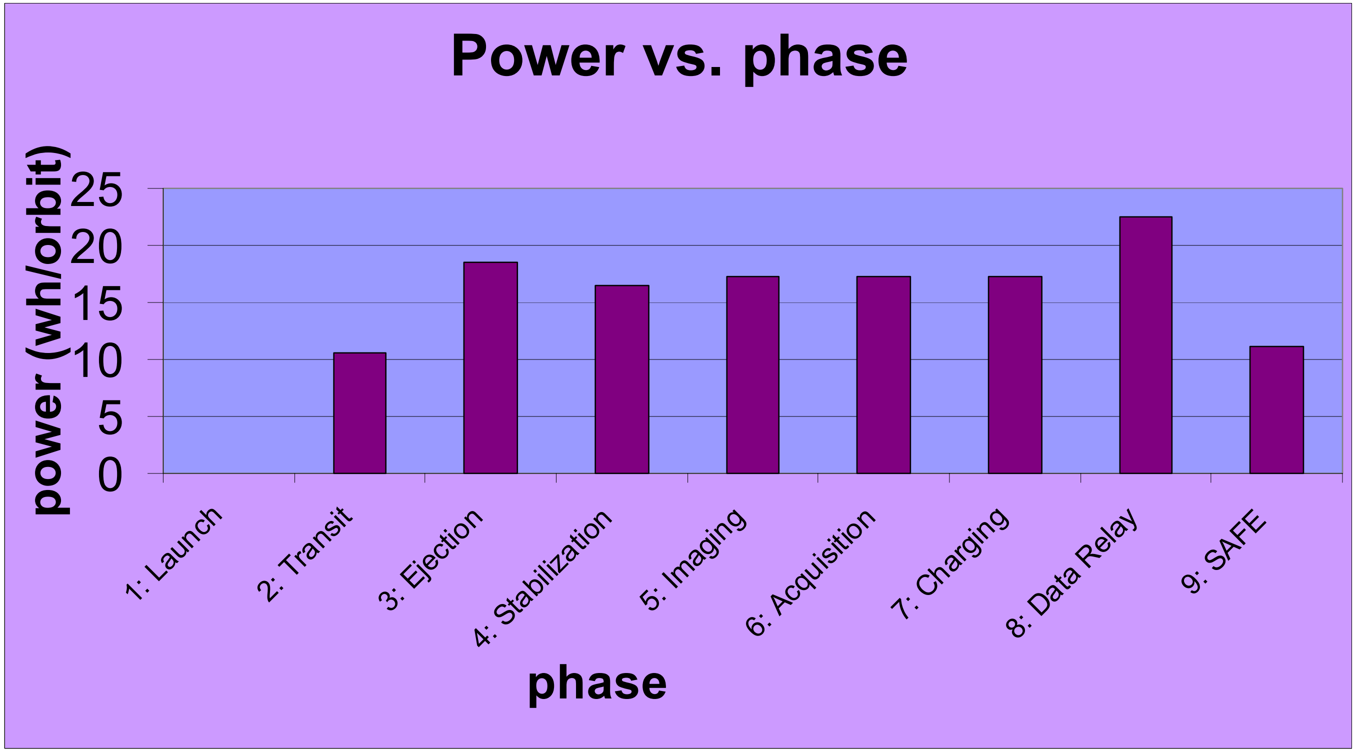
Block Diagram



Examples of Trades and Design Work



Examples of Trades and Design Work



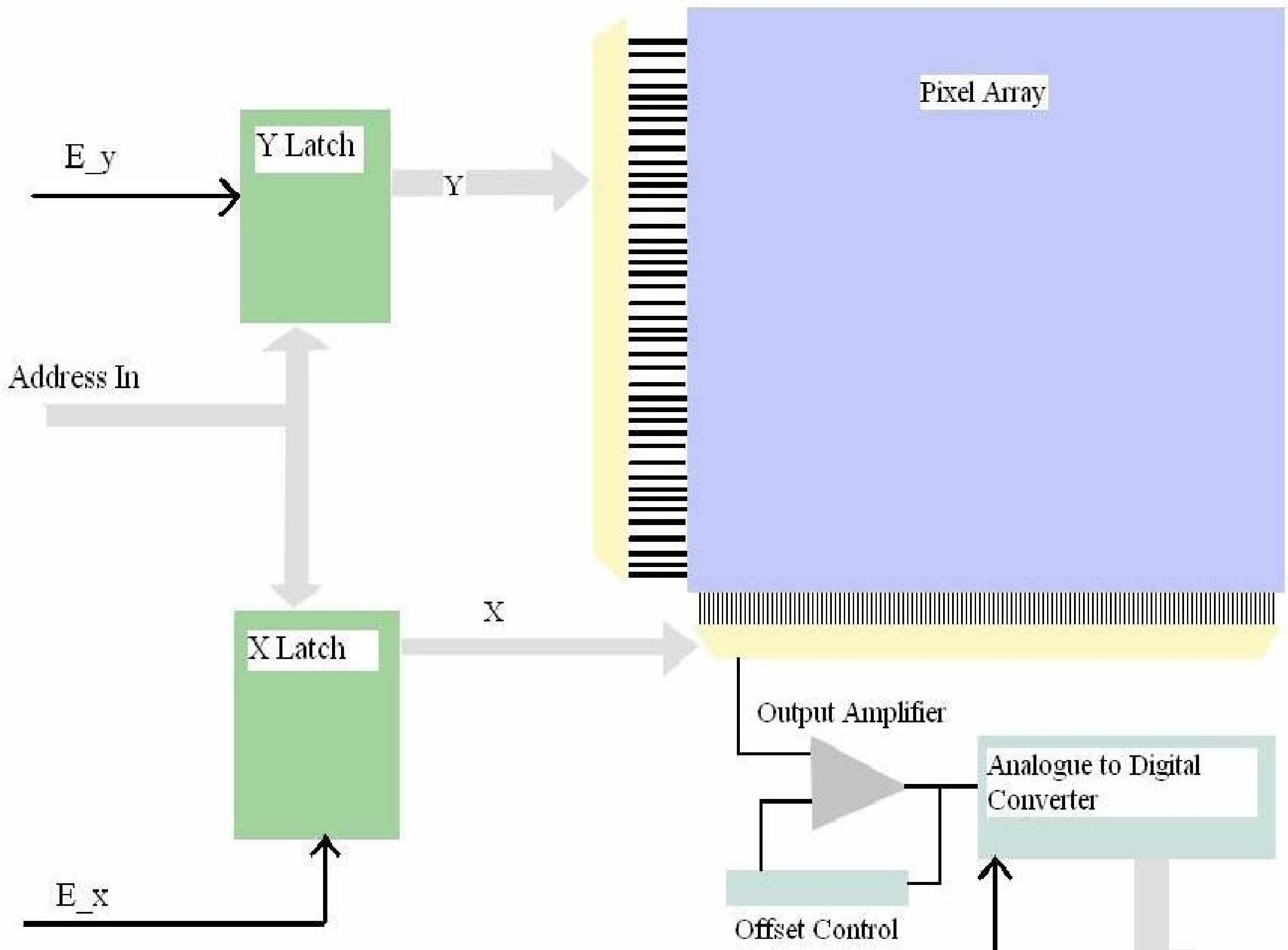
Phase	Power
1: Launch	0.00
2: Transit	10.52
3: Ejection	18.57
4: Stabilization	16.52
5: Imaging	17.28
6: Acquisition	17.29
7: Charging	17.28
8: Data Relay	22.53
9: SAFE	11.13

- Maximum power consumption occurs in the eighth phase which is the data relay phase.

Examples of Trades and Design Work

- F-number: 1.4
  - Constrained by VMS (Visual Monitoring System) document
- Full field-of-view: 30 degrees
- Focal Length: 2.87 cm
- Aperture Diameter: 2.052cm
- Accuracy of 200 arc seconds
- 500 star catalog

Examples of Trades and Design Work



Lessons Learned

- It is possible to have a successful multi-institutional collaborative design project.
- A large database of Martian information was collected and a greater understanding of Martian missions was attained.
- Ability to apply mARZSat concept study to other missions.