



# Mission Enabling Compact Avionics Systems

*Next Generation Cubesat Bus Design*

Brian Tubb

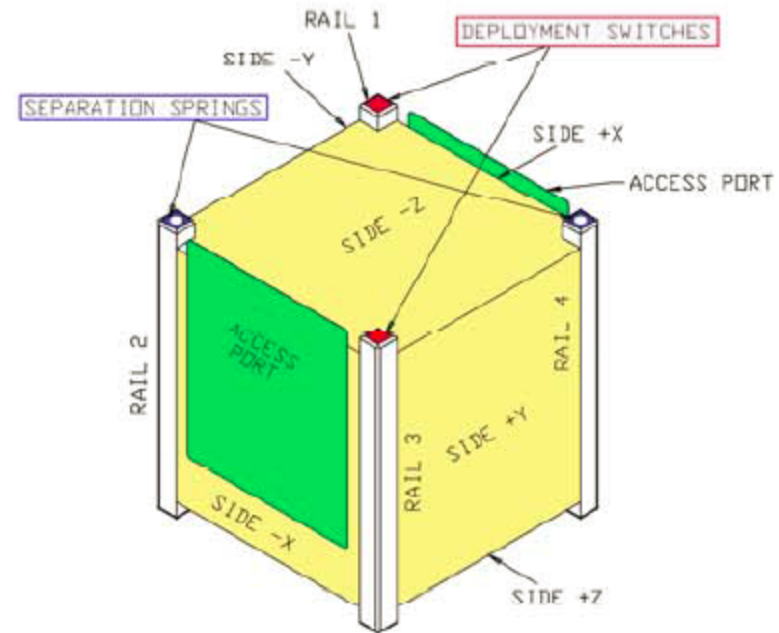


# Outline

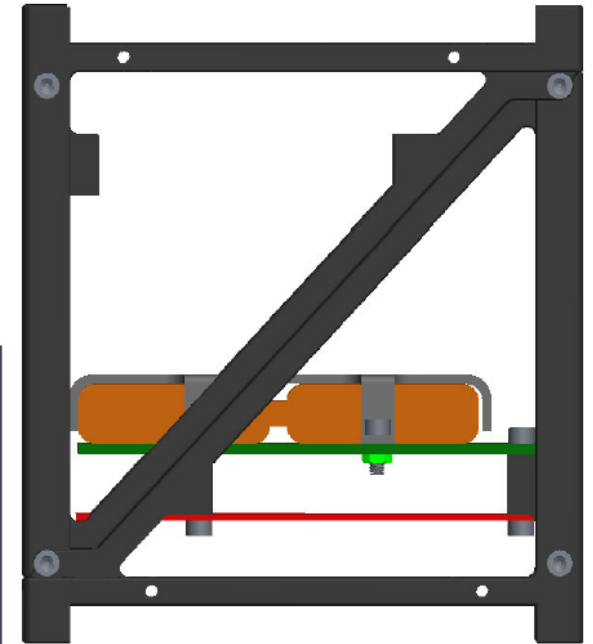
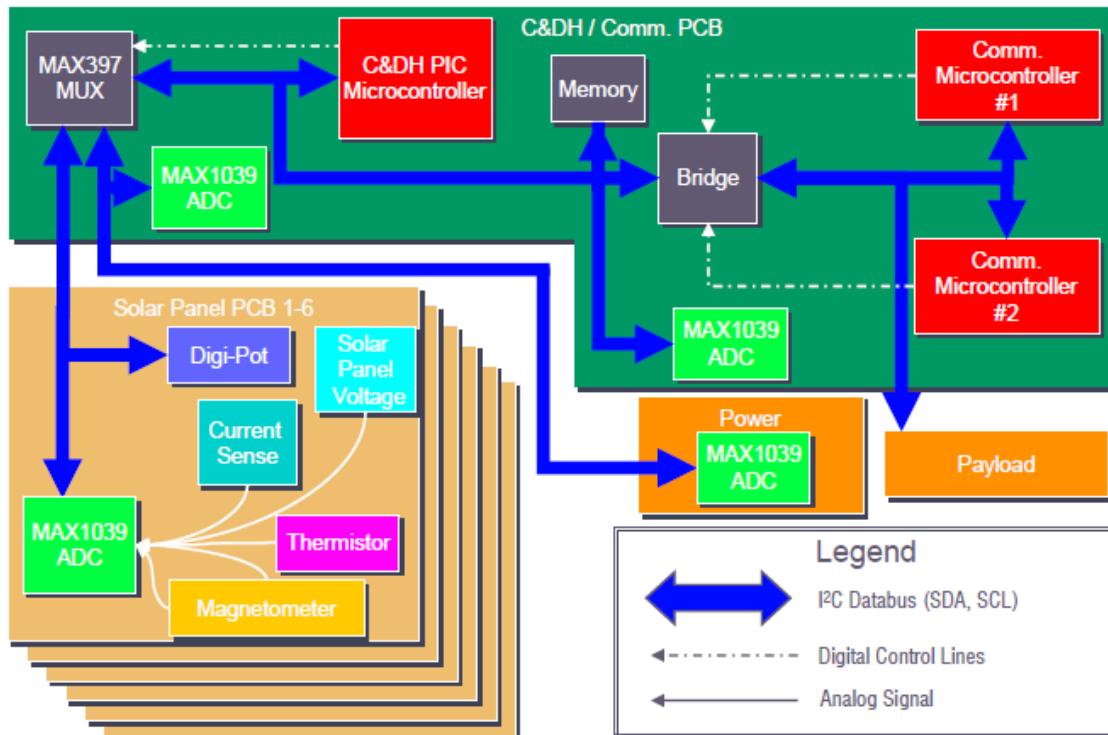
- Cubesat Limitations Rundown
- Previous Bus Design
  - Results and Problems
- Paradigm Shift with Lightsail and CP7
  - New Requirements
- *New Bus Design*
  - Design Philosophy
  - System Board and Software improvements
  - Interfaces and Structure
- Conclusions

# Cubesat Limitations

- Price
- Volume
- Power



# Legacy Design CPx Bus



Two Avionics Boards:  
 • C&DH + Comm  
 • Power Board



## Legacy Design CPx Bus

### Flights:

- CP3
- CP4
- CP6
- CP5 [integration stages]

### Issues:

- Struggle with COMM system required multiple C&DH revisions
- Proprietary  $\mu$ Controller programming software
- Redundancy caused more issues than stability
  - Interprocessor Communications
  - Layout/Assembly complexity
  - Core Bus takes up large volume



# New Polysat Projects

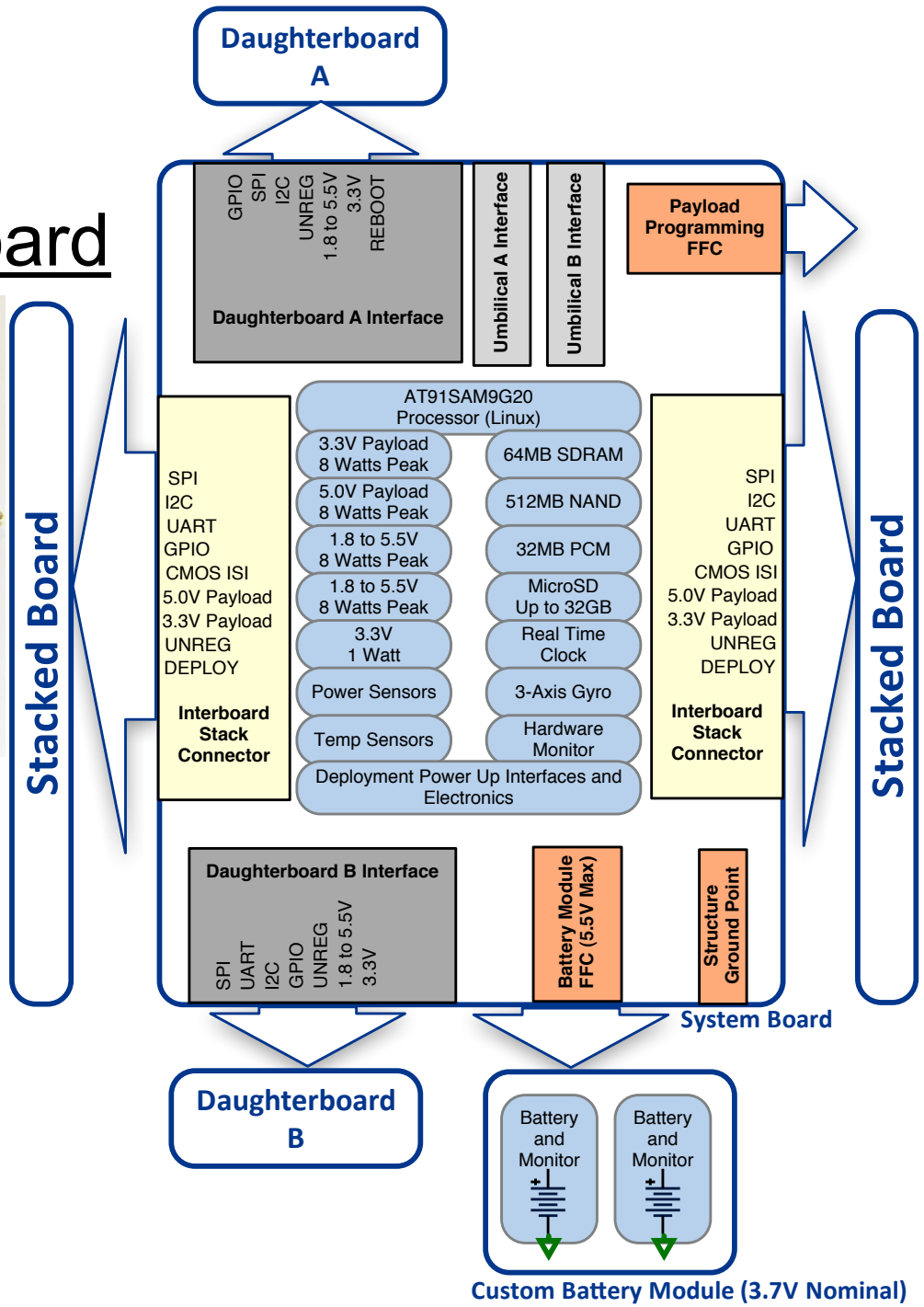
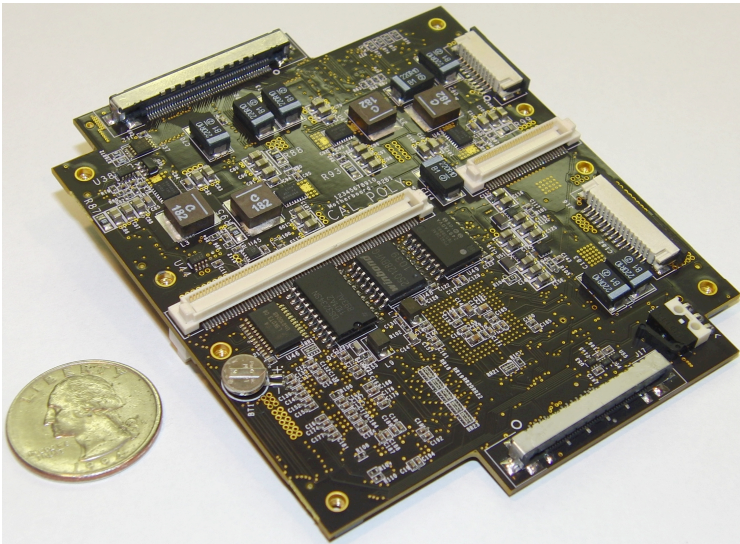
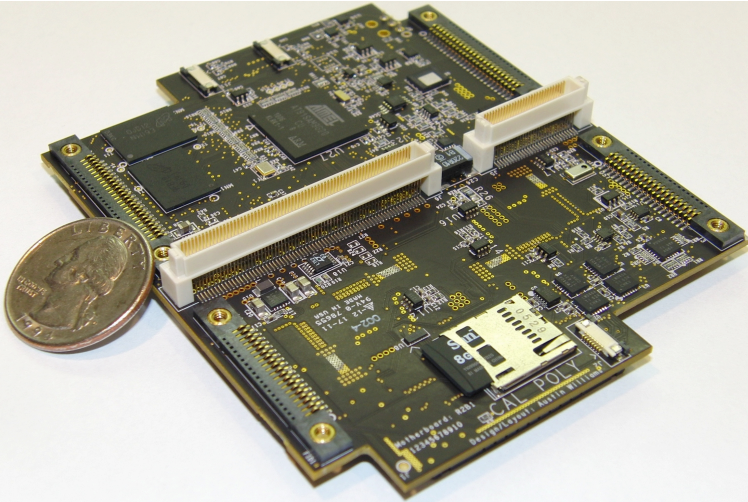
## CP7 and Lightsail

*New Design Requirements*

- Large Payload Volume Requirements
- High Power Consumption
- Massive amounts of data
- Battery form factor

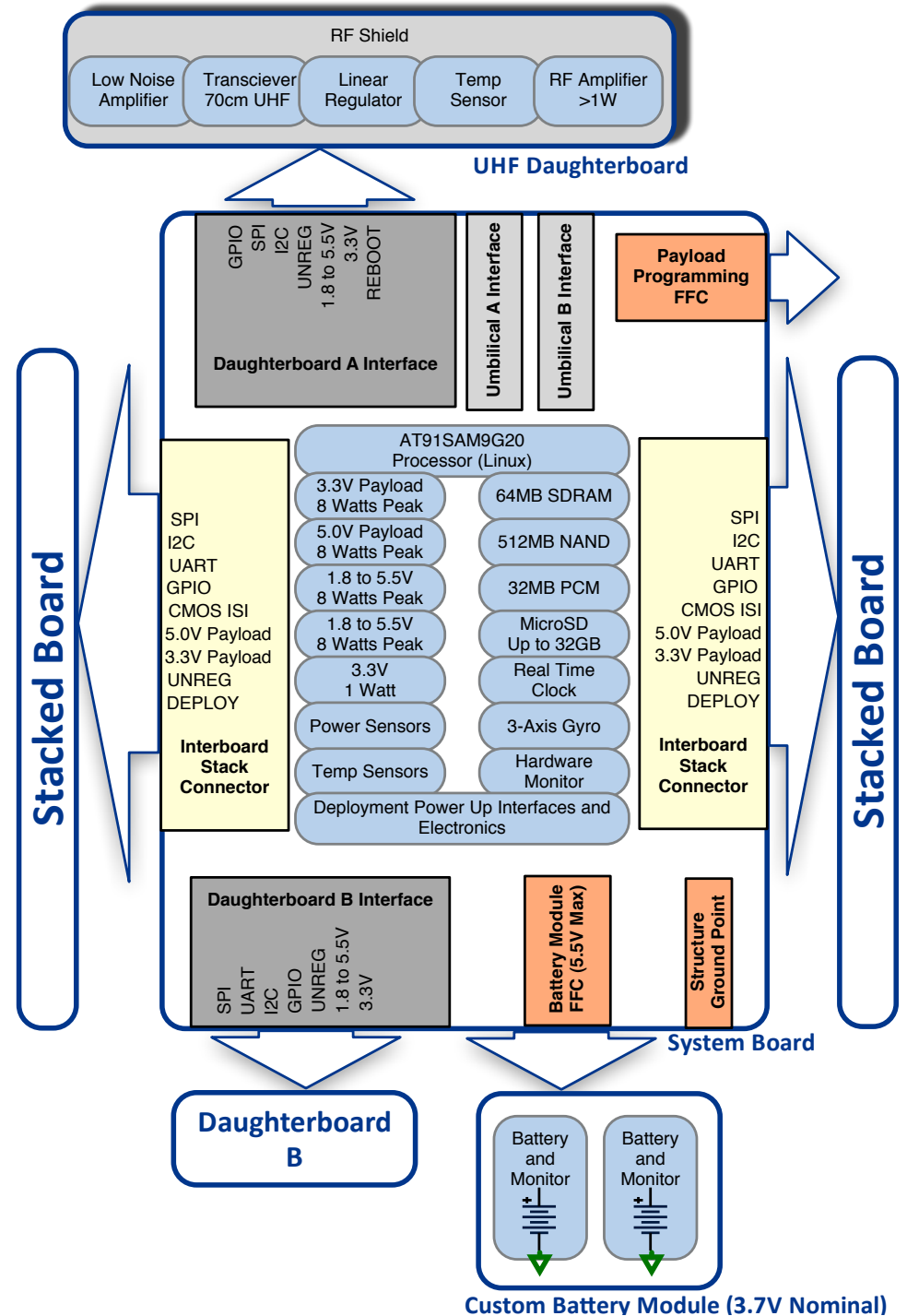
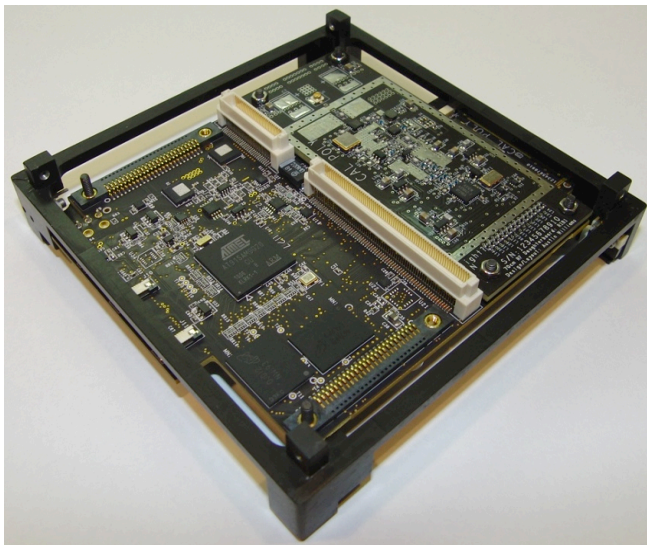
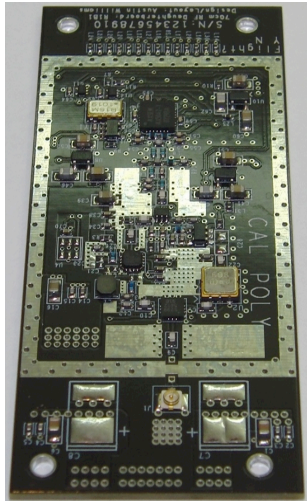


# Next Gen System Board





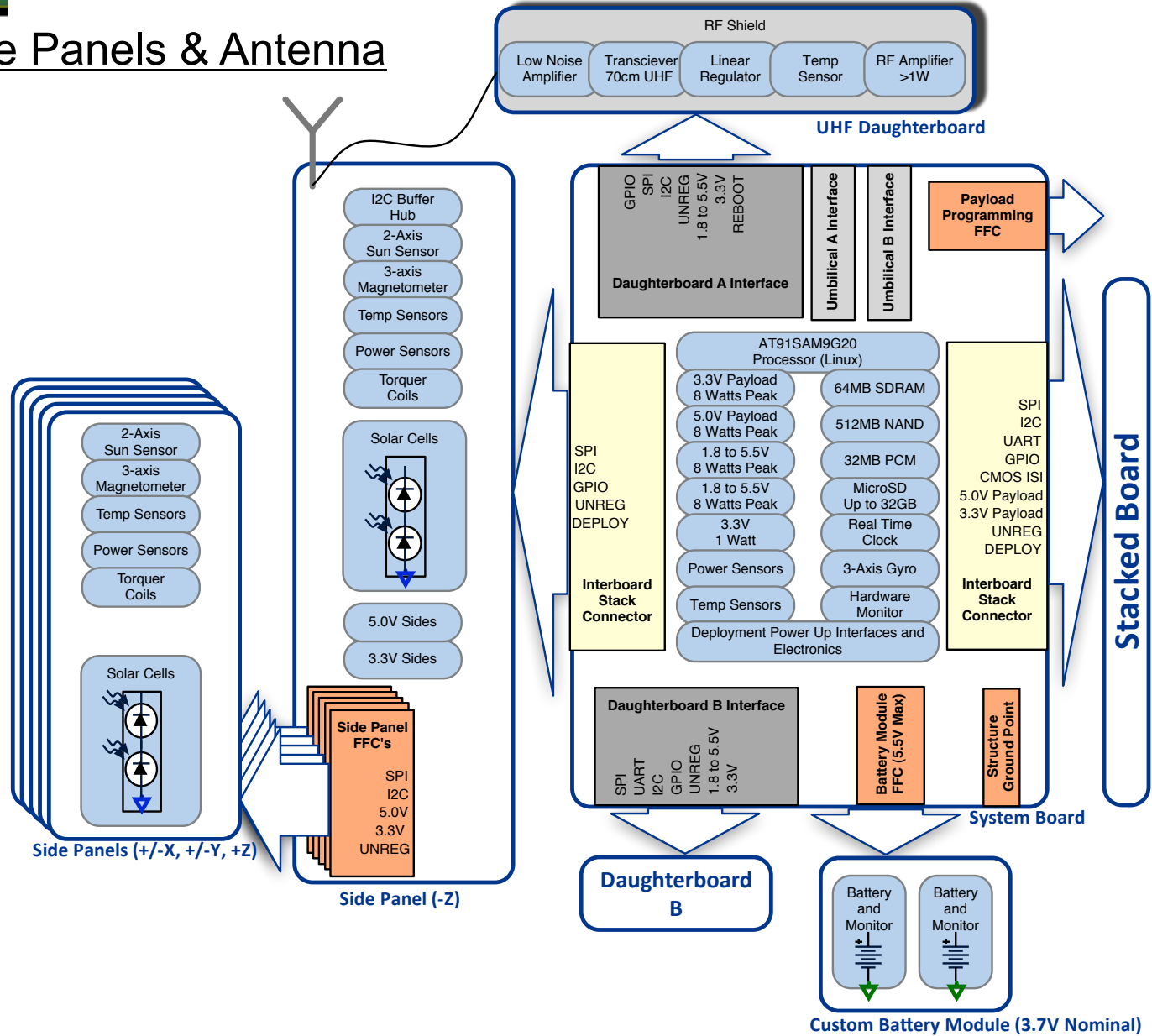
# ...Add UHF Comm







## ...Add Side Panels & Antenna



Stacked Board

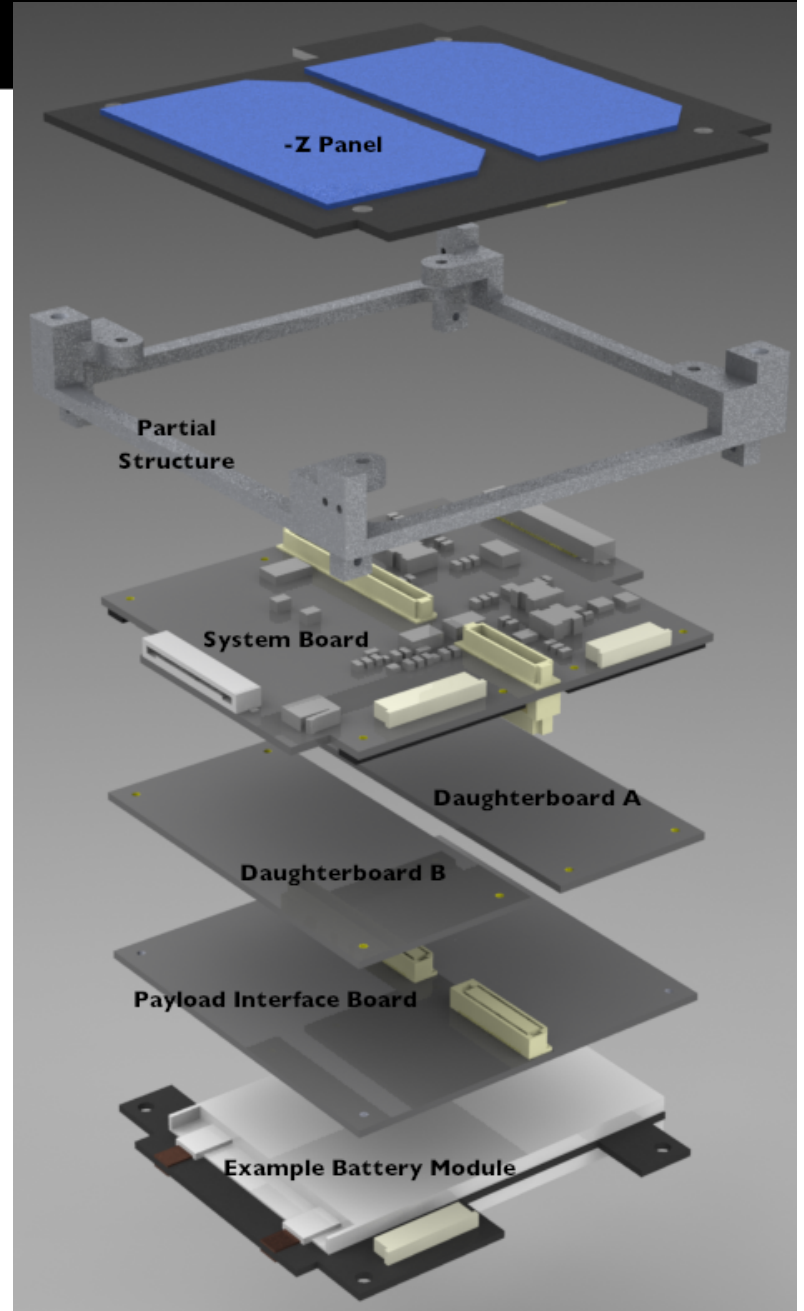
Daughterboard B

Custom Battery Module (3.7V Nominal)



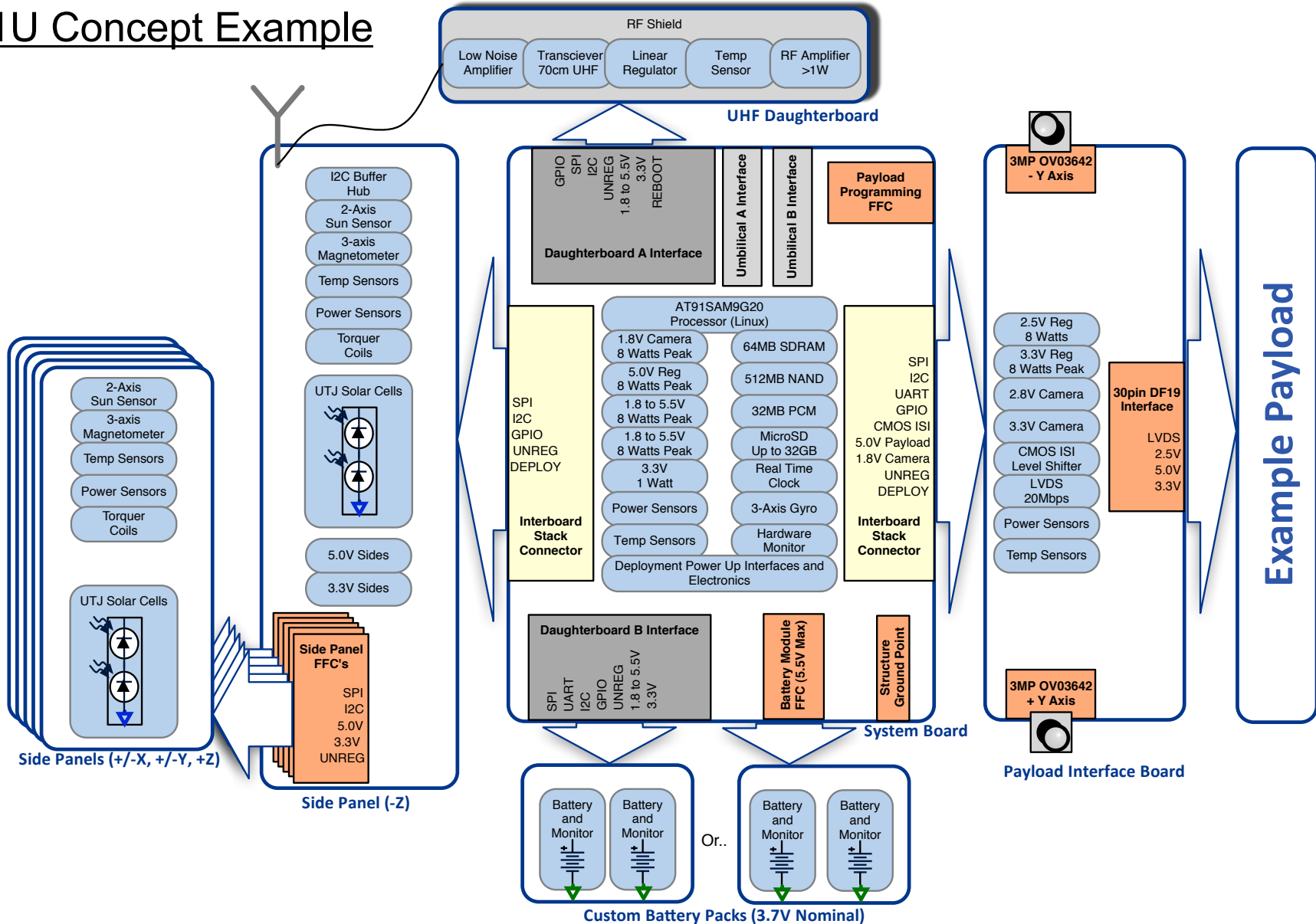
# 1U CubeSat

~30mm



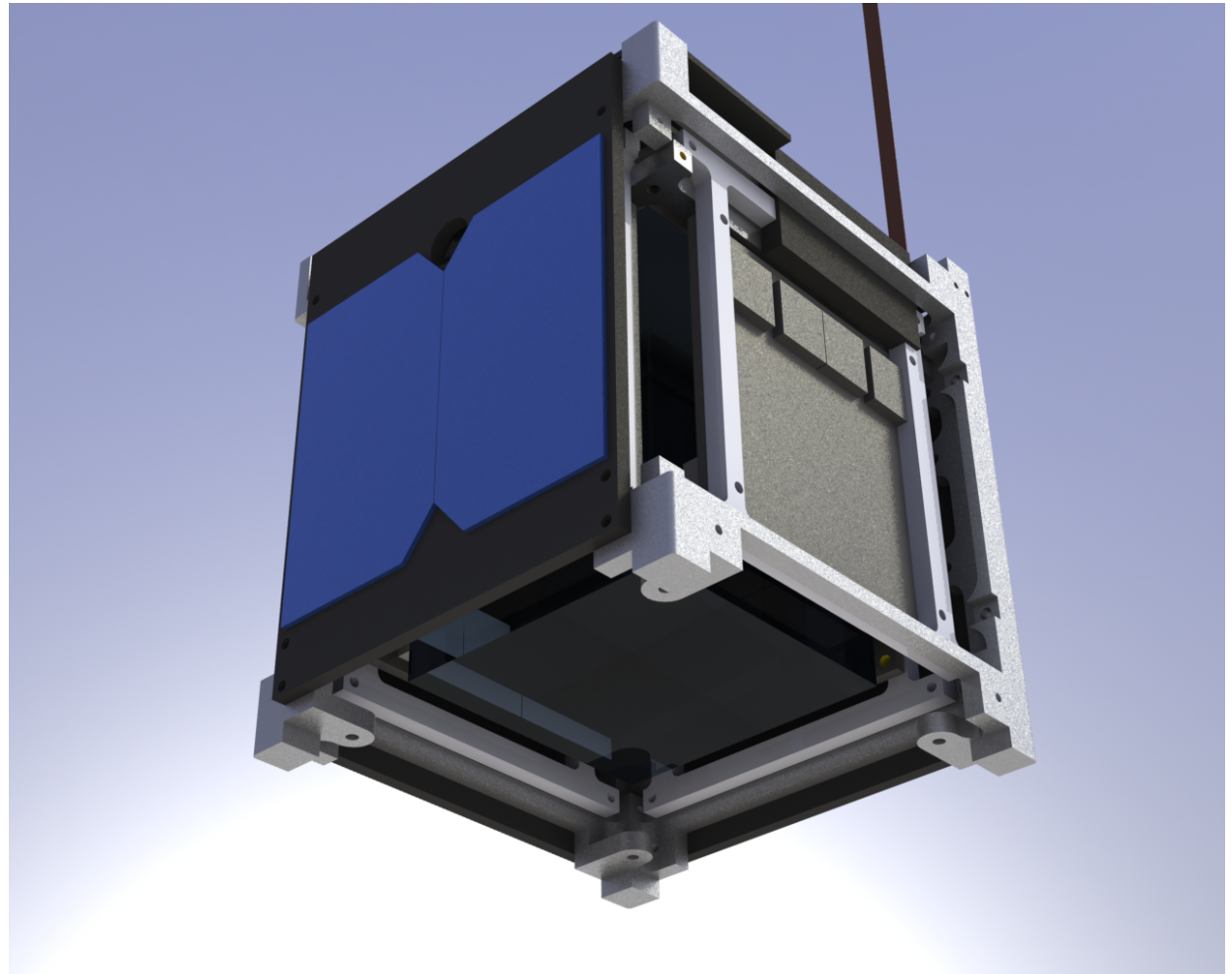


# 1U Concept Example



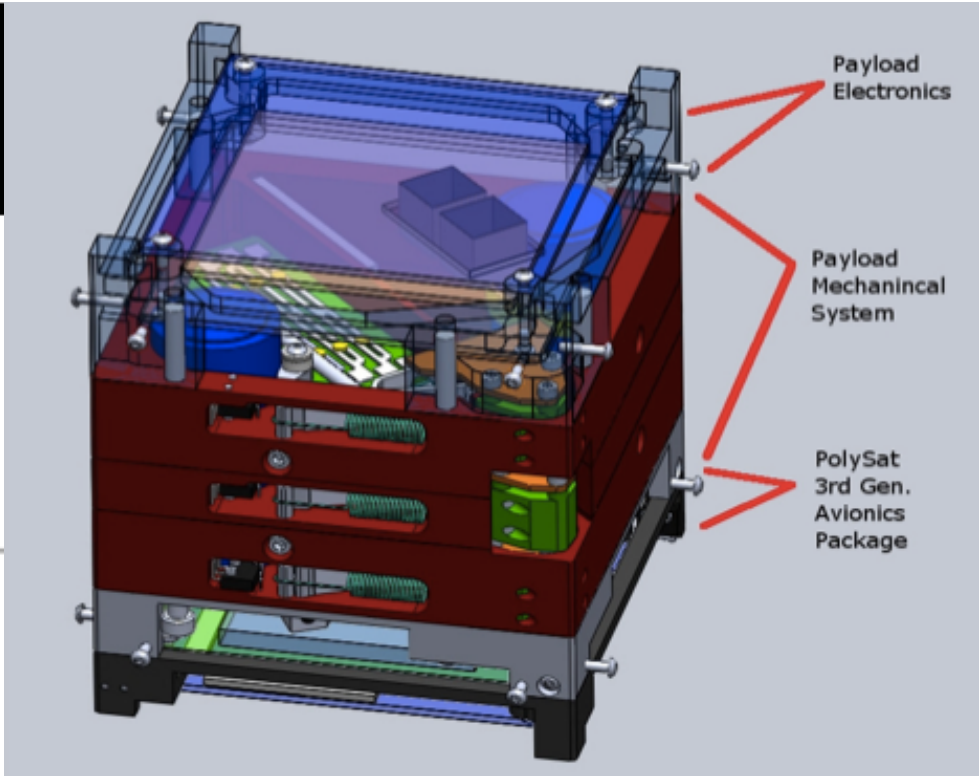
## 1U Concept Example

- ~23mm Avionics
- Custom Battery Pack fits in nooks and crannies based on Payload geometry
- Two 3MP imagers included in first 23mm. Do not interfere with Solar Cells





CP7 Example



CP7 Payload



## CPx Legacy Bus

- Integrated Comm and C&DH into one PCB
- Separate power board with battery monitors with connectors to side panels and payload

Multiple Comm issues required C&DH redesigns, resulting in multiple code bases, scattered designs, and inability to 'black box' design.

## Next Gen Bus

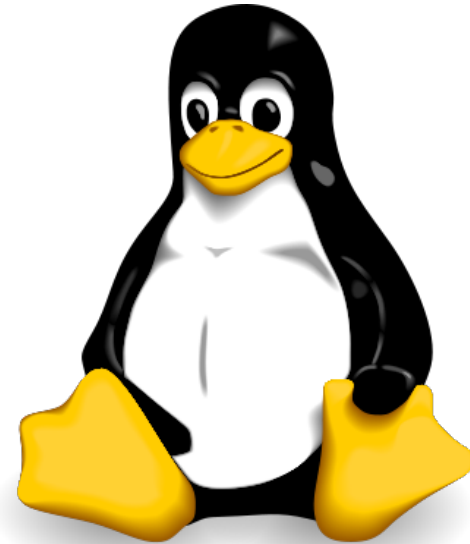
- Integrated Power and C&DH into one PCB
- Separate Comm daughterboards

RF is difficult to design. Separating the rest of the system mitigates noise, simplifies testing, and allows flexibility in the Comm system.

Separate Battery Board for flexibility in choice and mounting location.

## Software

- Linux 2.6 kernel
- Memory management, process handling, and communication protocols 'free'
- Linux experience common in Universities
- Stable code base for future development





# Opportunities and Implications

- Remote Development
- Students familiar with Linux through basic classes
- Flexibility where it counts
  - Comm system
  - Battery Module
  - Panel Development
- Shorter development cycle
- Larger focus on payload



## Conclusion

- ‘Smartphone’ design philosophy
  - More capable, more stable
  - Developer friendly: Linux, SSH, Umbilical
- Payload Focus
  - Larger available volume
  - Mission-Adjustable Battery Module
  - More stable avionics = quicker delivery