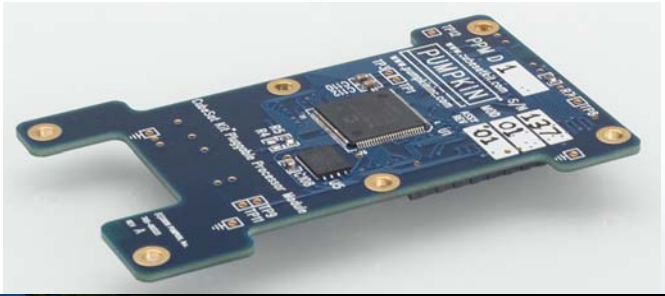
Recent Developments in Pumpkin's CubeSat Kit™ Architecture

Andrew E. Kalman aek@pumpkininc.com

President & CTO, Pumpkin, Inc.

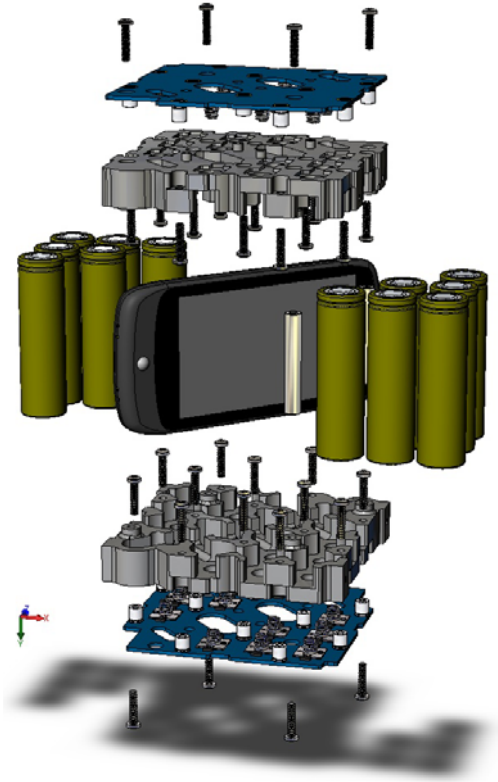
A Common Base Enables Sharing

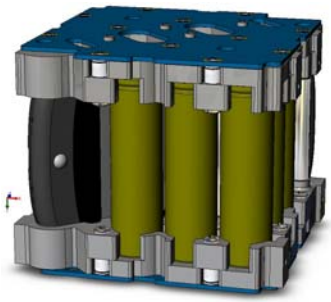
- CubeSat Kit (CSK) shipments now number in the 200's …
- This much common hardware begs for teaming …
- And that is finally happening!
- Typical scenario is software and subsystem development, testing & validation, spread across disparate geographic locations and done on CSK Development Boards …
- PIC24- and dsPIC33-based CSKs appear to be currently most popular due to MIPS, I/O capabilities and free software (compilers, IDE, peripheral libraries)



PhoneSat Li-Ion Power Pack

- In partnership with NASA ARC
- Utilizes Google Nexus One Android-based smartphone
- A very tight fit inside a 1U CubeSat (assumes phone is *not* disassembled)
- Rapid development cycle(s) meant that initial PhoneSat mission would be with (primary) batteries only.
- Complex battery holder possible via 3D rapid prototyping
- 1S12P array of 18650-size Li-Ion cells (>100Wh), fully protected
- Available now





nanoLab Kit™

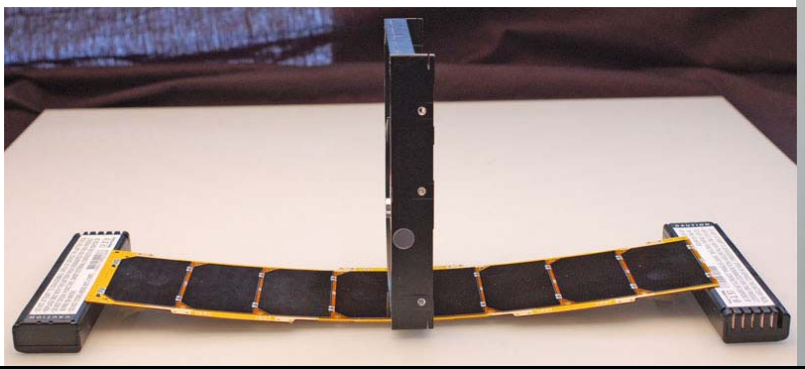
- NanoRacks™ can be filled with flightless CubeSats that appear as USB Mass Storage Class devices
- Uses USB OTG-based PSPM & PPM. With royalty-free Microchip® USB stack it can behave as a USB MSC device for NanoRacks compatibility
- 64Mbit flash + GBs of storage via SD Card
- Builds on space-proven CubeSat Kit technology, w/similar pricing
- Availability
  - 1CU kits available now
  - 2CU, 3CU, 4CU, 2x2CU, 3x2CU, 4x2CU kits as demand warrants

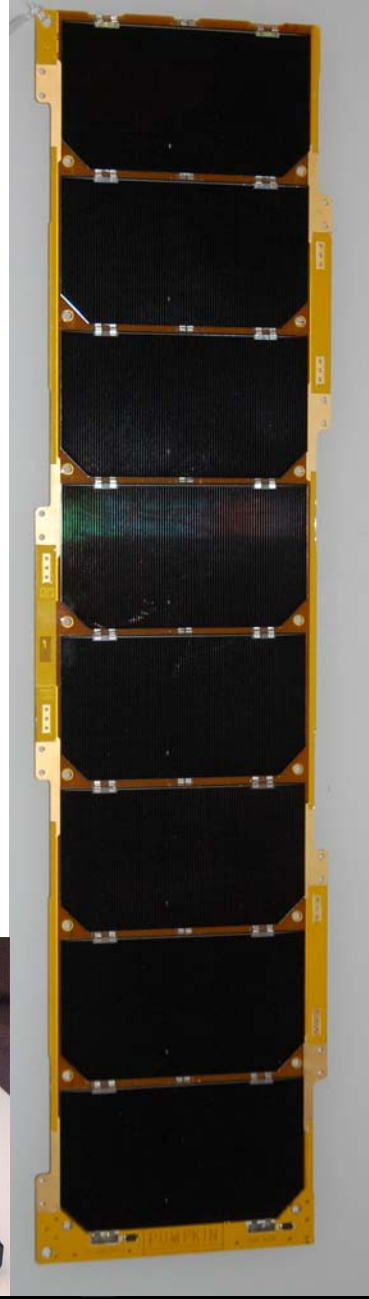
New PPM E1 & PSPM E

- P(S)PM D1 (w/PIC24FJ256GA110) has lots going for it:
  - 16 MIPS, only 800uA/MIPS
  - 4 x UART, 3 x SPI, 3 x I2C
  - 16 x 12-bit Analog Inputs
  - 64Mbit Flash memory
  - “Steerable” digital peripherals via Peripheral Pin Selects
  - but only 16KB on-chip RAM
- So, PPM E1 gets the PIC24FK256GB210, with:
  - 96KB RAM (& 256KB Flash)
  - USB OTG
- Why E1? Why not D3?
- Availability
  - PSPM E now, PPM E1 soon

Solar Panels

- Not everyone needs >50 watt arrays
- Fixed panels
- Panel family expanding to 1U, 2U, 3U
  - COTS
  - Semi-custom
  - Full Custom
- Building now
- Spectrolab UTJ cells in stock for short delivery times

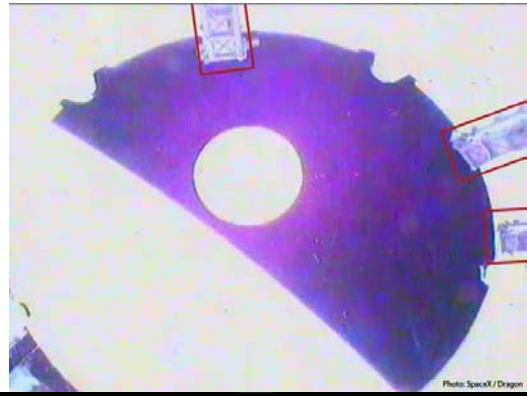




Deployable Solar Arrays

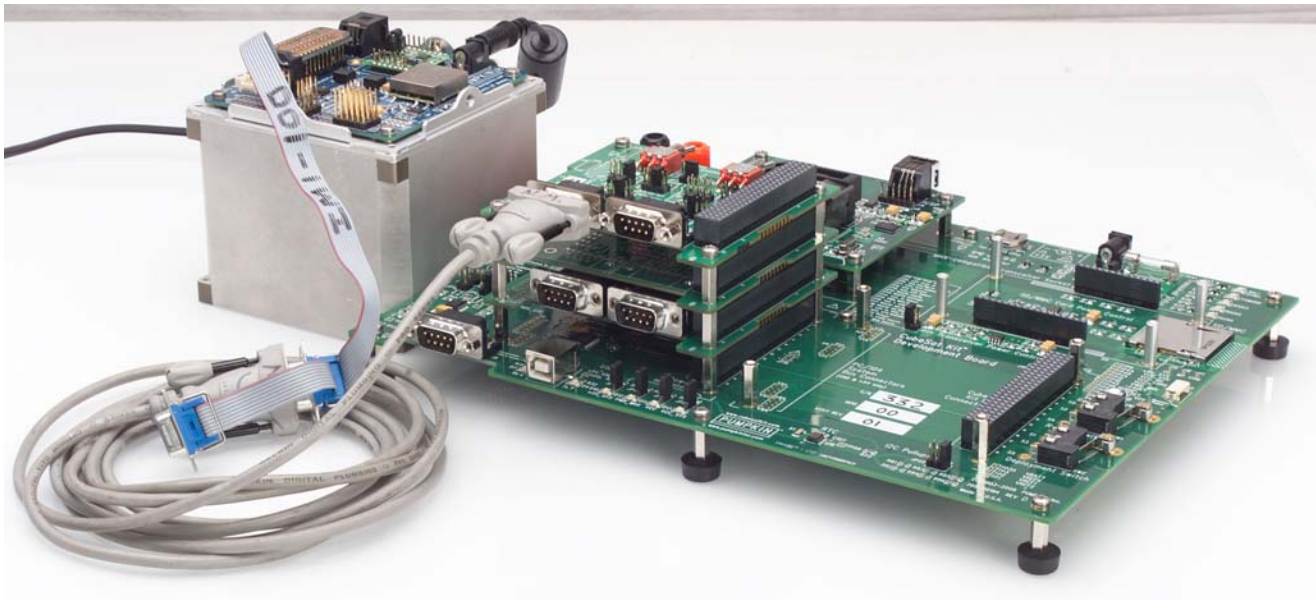
- Technology flow-down from high-power array flown on Caerus/Mayflower mission in Q4 2010
  - 8 deployed panels
  - In one plane
  - 56 UTJ cells
  - Thermal management

- Aerospace Corp. methods
- Solar cells aren't getting any cheaper ☹
- Array can be deployed from either, or both, ends of a 3U
- CSK Hinge family is expanding
- Exploring (much) lighter arrays



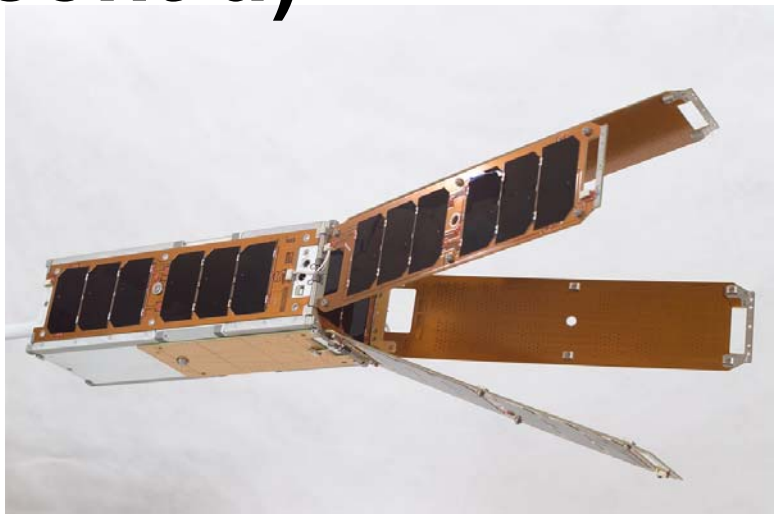
MISC Developments

- Bus Flight & Ground Station Software
  - Pumpkin partnering with Maryland Aerospace, Inc. (MAI)
  - Leverages MAI's parallel development of microsat mission software.
  - Flight SW runs on CSK PPM D1
  - Supports HITL simulations
  - Demos here at SSC2011

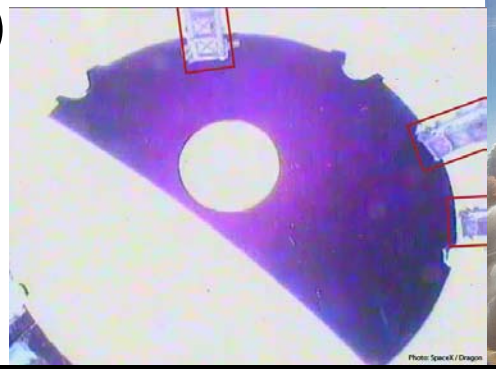


MISC Developments (cont'd)

- 14th MISC bus sold
- 'Colony' class 3U 3-axis control
- U.S. Gov't customer – AFRL
- 2nd Block III unit
- Delivery in ATP + 60 days



- Customer leverages NRL-developed flight and ground software to minimize development times and expenses.
- Utilizes PPM B1 (C8051-based)
- Sister to QbX1 & QbX2 (launched Q4 2010)



Next Generation Bus – MISC 3

- In final design stage
- Customizable with customer input
- Evolution of space-proven Pumpkin designs
- 2U Payload volume
- 50W power class
- More PPMs coming
- Improved ADACS
- Includes flight software
- Delivery within 5 months ATP
- Option for propulsion

Talk to us at SmallSat – Booth 16

Q&A Session

PUMPKIN™
SPACE SYSTEMS

Thank you for attending this Pumpkin presentation at the 2011 CubeSat Summer Developers Workshop!

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Appendix

- Speaker information
  - Dr. Kalman is Pumpkin's president and chief technology architect. He entered the embedded programming world in the mid-1980's. After co-founding Euphonix, Inc – the pioneering Silicon Valley high-tech pro-audio company – he founded Pumpkin, Inc. to explore the feasibility of applying high-level programming paradigms to severely memory-constrained embedded architectures. He is the creator of the Salvo RTOS and the CubeSat Kit. He holds several United States patents. He is a consulting professor in the Department of Aeronautics & Astronautics at Stanford University and directs the department's Space Systems Development Laboratory (SSDL). Contact Andrew at aek@pumpkininc.com.
- Acknowledgements
  - Pumpkin's Salvo, CubeSat Kit and MISC customers, whose real-world experience with our products helps us continually improve and innovate.
- CubeSat Kit information
  - More information on Pumpkin's CubeSat Kit can be found at http://www.cubesatkit.com/. Patented and Patents pending.
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First presented at the CubeSat Developers' Workshop in Logan, Utah on Sunday, August 7, 2011, prior to the 25th Annual AIAA/USU Conference on Small Satellites.