CubeSat Parts Database: NASA Usage and Kit Manufacturers

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Approach/Sources

- Discussions with PI’s
- CubeSat/Small Satellite Conferences
- Mission/University Websites
- Published Professional Literature
- NASA CubeSat Developers
NASA CubeSats

- Ames Research Center (ARC) – 17
- Jet Propulsion Laboratory (JPL) – 9
- Goddard Space Flight Center (GSFC) – 9
- Kennedy Space Center (KSC) – 2
- Marshall Space Flight Center (MSFC) – 1
- Langley Research Center (LARC) – 1
- All NASA Centers – 39 Total
- Launched - 13
Microcontrollers/FPGAs

- **Atmel**
  - ATMEGA2560/A328 8-bit Microcontroller
  - ATmega164P
  - ARM9

- **TI**
  - MSP430 16-bit Microcontroller
  - OMAP3503/ARM Cortex-A8

- **Microchip 32-bit Flash & Non-Flash Microcontroller**

- **Stamp9G20 processor**

- **Colibri PXA270 (Intel/Marvel ARM PXA270)**

- **Xilinx**
  - V5QV and FX130T

- **Aeroflex UT6325 Eclipse FPGA**
Memories

- Numonyx P5QPCM 128 Mb Phase Change Memory
- Xilinx 32 Mb XQF32P Flash PROM
- Everspin MR4A16B MRAM
- Microchip 256 kb EEPROM
- Aeroflex 4 Mb SRAM
- Dallas 1 kb EEPROM
- Ramtron 1 Mb FRAM
- Delkin Devices MicroSD Card
- 3D Plus SDXX SDRAM
Communications

- Microhard MHX-2420 2.4 GHz Wireless Modem
- AstroDev CII Radio board
- Surrey 12-Channel GPS Receiver board
Power

- Clyde Space 3U EPS
- Clyde Space 30Wh Battery
- Buck-boost DC-DC converters
- SVGA05XX POL DC-DC converter
- LTC2309 ADC
- 1/2.5/3.3V POL
- DC-DC converter
Phone Sats

• HTC Nexus One phone
  – 1GHz Qualcomm QSD8250 Snapdragon
  – Samsung 943 KA100O015M
  – Skyworks SKY77336 GSM power amp
  – Qualcomm PM7540 power management
  – TI TPS65023 power management
  – Audience A1026 voice processor
  – Broadcom BCM4329 Bluetooth/802.11n
  – Synaptics T1007A capacitive sensor

• Arduino test board (ATMEGA 328)
• StenSat AFSK beacon radio
• 2x10⁻⁶ torr/-35C to 65C
Phone Sats

• Nexus S phone
  – Skyworks SKY77529 GSM/GPRS/EDGE
  – SanDisk SDIN4C2 16GB MLC NAND Flash
  – Samsung KB100DO0WM memory
  – Samsung S5PC110A01 Cortex A8 Hummingbird processor
  – Infineon 8824 XG616 Baseband processor
  – Wolfson Microelectronics WM8994 audio codec
  – Broadcom BCM4329GKUBG TE1043 WiFi

• Propeller P8X32A microcontroller support
Other

- OmniVision 2 MegaPixel CMOS camera
- AD7714 ADC
- Custom ASIC
- Passive thermistors
- LVDS/RS422 transceivers
- Analog Multiplexerer
- No mention of passive grades, types etc.
- Mention of 0 to 70C and 0 to 85C graded parts
- Some assemblies are -20C to 50C
Cubesat Vendors

- www.cubesat.org
- 21 Vendors
- Wide range of subsystems to complete vertical integrated launch companies
- Microcontroller focused (8 and 16 bit)
  - TI MSP430/Silicon Labs C8051/Microchip PIC24/dsPIC33
- Only one company mentioned anything about components/parts
  - Solder & workmanship/pure-tin/EEE parts screening/obsolescence
- Two companies mention testing EMI/EMC testing
- “Reliability” only mentioned once
- One private discussion ‘consider’ automotive ‘if possible’
- Digikey
- Some temperature testing of final PBW, some only in design phase
- Performance based specs and product offerings
Conclusions

• Mature part technologies => low cost, low power
• Majority of NASA CubeSats are in development and do not have finalized parts lists
• NASA centers primarily build custom boards with a combination of COTS and high-reliability parts
Backup – NASA CubeSat Missions
## NASA CubeSats (cont.)

<table>
<thead>
<tr>
<th>Mission</th>
<th>NASA Center</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>EcAMSat</td>
<td>ARC</td>
<td>Hardware development complete, waiting for launch opportunity</td>
</tr>
<tr>
<td>EDSN</td>
<td>ARC</td>
<td>Planned launch late 2014</td>
</tr>
<tr>
<td>GeneSat</td>
<td>ARC</td>
<td>Launched December 2006, deorbited August 2010 (no failure)</td>
</tr>
<tr>
<td>Lightsail</td>
<td>ARC</td>
<td>In development, planned launch 2016</td>
</tr>
<tr>
<td>O/OREOS</td>
<td>ARC</td>
<td>Launched November 2010, began experiencing low battery voltage and unexpected system resets in April 2011</td>
</tr>
<tr>
<td>PharmaSat-1</td>
<td>ARC</td>
<td>Launched May 2009, deorbited August 2012 (no failure)</td>
</tr>
<tr>
<td>PhoneSat 1A (Graham)</td>
<td>ARC</td>
<td>Launched April 21, 2013, deorbited April 27, 2013 (no failure)</td>
</tr>
<tr>
<td>PhoneSat 1B (Bell)</td>
<td>ARC</td>
<td>Launched April 21, 2013, deorbited April 27, 2013 (no failure)</td>
</tr>
<tr>
<td>PhoneSat 2.4</td>
<td>ARC</td>
<td>Launched November 2013, began experiencing recurring upsets in January 2014</td>
</tr>
<tr>
<td>PhoneSat 2.5</td>
<td>ARC</td>
<td>Launched April 2014, deorbited May 2014</td>
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<tr>
<td>PhoneSat 2A (Alexander)</td>
<td>ARC</td>
<td>Launched April 21, 2013, deorbited April 27, 2013</td>
</tr>
<tr>
<td>PreSat</td>
<td>ARC</td>
<td>Launch failure</td>
</tr>
<tr>
<td>SporeSat</td>
<td>ARC</td>
<td>Launched April 2014, fully operational</td>
</tr>
<tr>
<td>TechEdSat-1</td>
<td>ARC</td>
<td>Launched October 2012, deorbited May 2013 (no failure)</td>
</tr>
<tr>
<td>TechEdSat-3</td>
<td>ARC</td>
<td>Launched October 2013, deorbited January 2014 (no failure)</td>
</tr>
<tr>
<td>TechEdSat-4</td>
<td>ARC</td>
<td>Unknown</td>
</tr>
<tr>
<td>BioSentinel</td>
<td>ARC</td>
<td>In development, planned launch in 2017</td>
</tr>
<tr>
<td>CeREs</td>
<td>GSFC</td>
<td>Unknown</td>
</tr>
<tr>
<td>CRaBSS</td>
<td>GSFC</td>
<td>Unknown</td>
</tr>
<tr>
<td>ESCAPE</td>
<td>GSFC</td>
<td>Proposed, not selected</td>
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<tr>
<td>Firefly</td>
<td>GSFC</td>
<td>Launched November 2013, fully operational</td>
</tr>
<tr>
<td>HeDI</td>
<td>GSFC</td>
<td>In development</td>
</tr>
<tr>
<td>IceCube</td>
<td>GSFC</td>
<td>In development</td>
</tr>
<tr>
<td>MaRBLES</td>
<td>GSFC</td>
<td>Proposed, not selected</td>
</tr>
<tr>
<td>SpaceCube v2.0 Mini</td>
<td>GSFC</td>
<td>In development</td>
</tr>
<tr>
<td>TechCube</td>
<td>GSFC</td>
<td>Proposed, not selected</td>
</tr>
<tr>
<td>CHIRP*</td>
<td>JPL</td>
<td>Proposed, not selected</td>
</tr>
<tr>
<td>GRIFEX</td>
<td>JPL</td>
<td>Planned launch December 2014</td>
</tr>
<tr>
<td>INSPIRE</td>
<td>JPL</td>
<td>Hardware development complete, waiting for launch opportunity</td>
</tr>
<tr>
<td>IPEX</td>
<td>JPL</td>
<td>Launched December 2013</td>
</tr>
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<tr>
<td>ISARA</td>
<td>JPL</td>
<td>In development</td>
</tr>
<tr>
<td>LMRST-Sat</td>
<td>JPL</td>
<td>In development</td>
</tr>
<tr>
<td>Lunar FlashLight*</td>
<td>JPL</td>
<td>In development, <strong>launch baselined for 2017</strong></td>
</tr>
<tr>
<td>NEAScout*</td>
<td>MSFC</td>
<td>In development, <strong>launch baselined for 2017</strong></td>
</tr>
<tr>
<td>M-Cubed/COVE</td>
<td>JPL</td>
<td>Launched October 2011 (magnetized to E1P-2 on deployment), re-flight in December 2013 (mission success)</td>
</tr>
<tr>
<td>RACE</td>
<td>JPL</td>
<td>Launch on ORB-3 from WFF in Oct 2014</td>
</tr>
<tr>
<td>CryoCube-1</td>
<td>KSC</td>
<td>In development</td>
</tr>
<tr>
<td>CryoCube-2</td>
<td>KSC</td>
<td>In development</td>
</tr>
<tr>
<td>Shields-1</td>
<td>LARC</td>
<td>In development</td>
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