CubeFlow, SPA and the revolution of small satellites

Cal Poly Workshop

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What is CubeFlow

- Under sponsorship by the Operationally Responsive Space (ORS) office, the Air Force Research Laboratory (AFRL) developed a modular nanosatellite approach where hardware and software “black-box” elements can be combined very quickly (possibly less than an hour) to form simple, but functional spacecraft.

- They are fully compliant with the Stanford/CalPoly CubeSat and Poly-Picosatellite Orbital Dispenser (PPOD) standards, but extend these standards by permitting interchangeability of components.

- As such, distributed groups can create individual component parts that can be brought together and quickly assembled using plug-and-play (PnP) mechanisms, similar to those in personal computers.

What are the CubeFlow parts?

- XTEDS – eXtended Transducer Electronic Datasheets. This is the datasheet for all hardware modules. A food processor has a datasheet, for SPA, the datasheet is an XTEDS.
- ASIM – Applique Sensor Interface Module. This holds the XTEDS. For SPA-U, this is usually modeled after an AT90USB device
- SDM – Satellite Data Module. This is the Linux OS that runs the CDH of the satellite and communicates with the ASIMs

Current status on ASIMs

- There are a wide variety of different ASIM platforms. Here are some examples:
  - Soft Core processor on FPGA (could go to SIRF)
  - Small Low Power ASIC (first silicon 2010)
  - Rad Hard version
  - Training versions based on AT90USB device

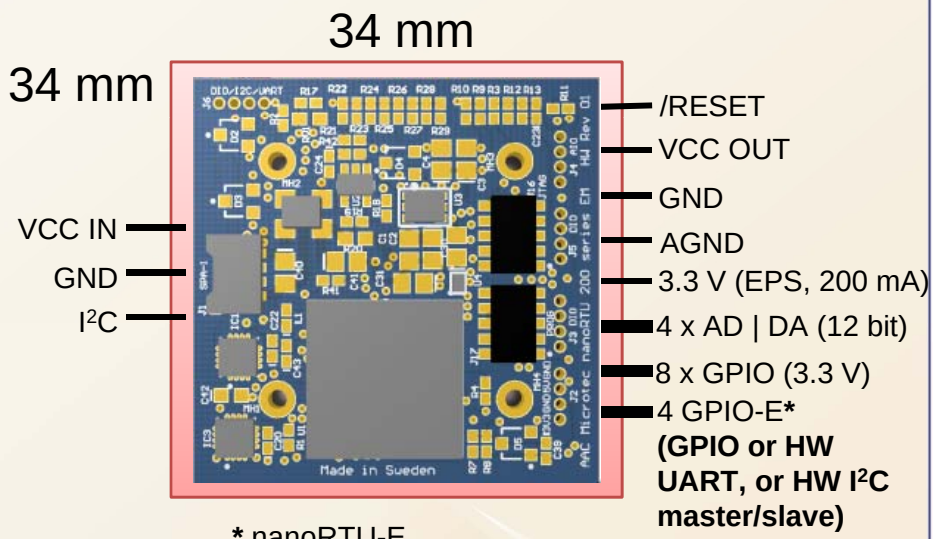
SPA

- SPA = Space Plug-and-Play Avionics
  - SPA-S = Spacewire
  - SPA-S(LV) = low voltage (5V) spacewire
  - SPA-U = similar to USB
  - SPA-1 = similar to I2C

Temp sensors, Electrical Power switches, Magnetic torquer control, Active heat control, house keeping, solar arrays, batteries, etc

Spa -1

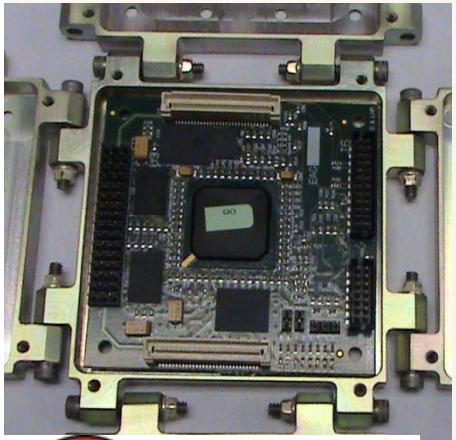
- ÅAC Microtec has developed first SPA-1 radiation tolerant device, “nanoRTU 200”.
- Compatible with Nano Modular Format (NMF, ¼ facet)
- TID: 20 krad, SEE immune (TMR, EDAC, Parity)
- Power consumption < 50 mW
- Support In-Circuit firmware & xTEDS update
- SPA-1 library developed by USU/SDL



* nanoRTU-E
Extended version only

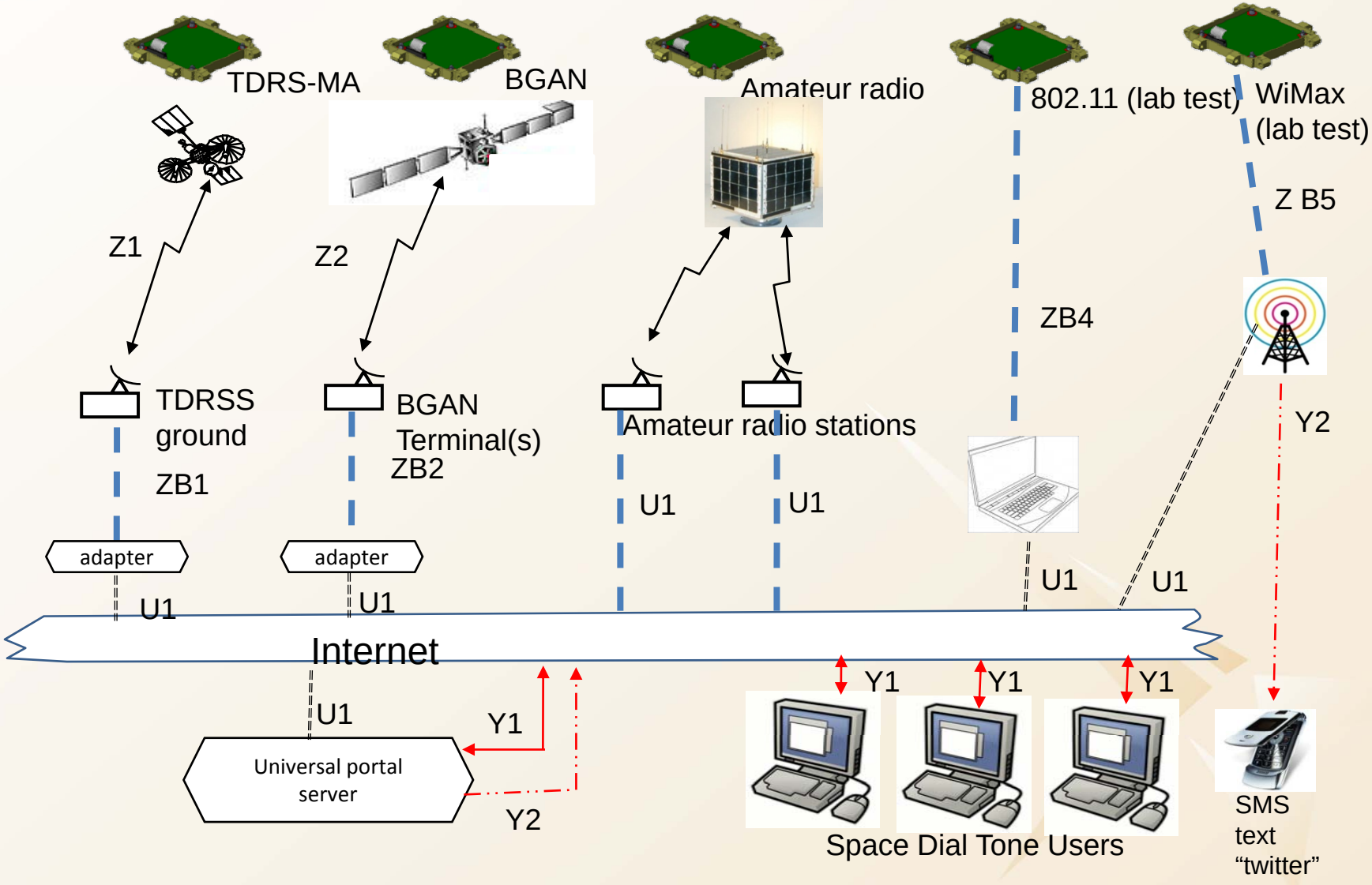
COSMIAC FPGA and SDR

- COSMIAC is taking an existing SPA-3A FPGA board and modifying it from it's configuration for image processing into a SPA Software Defined Radio Platform

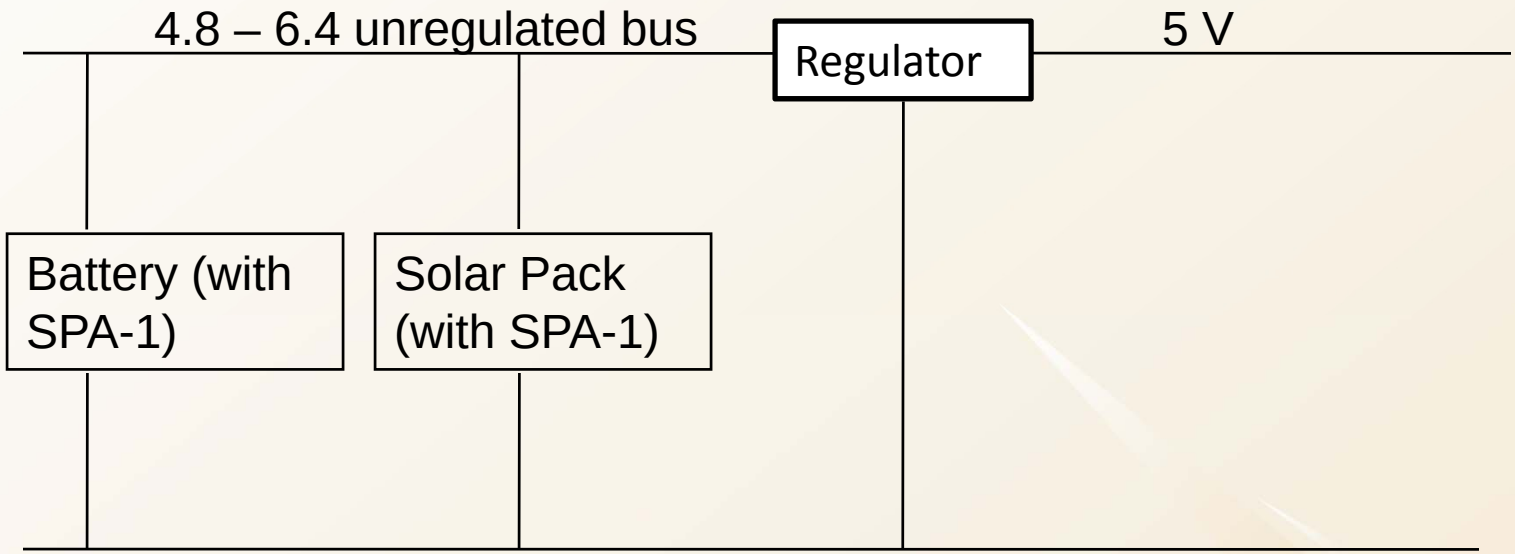


Project is modeled after USRP platform

Space Dial Tone



Lego Power



Solar Pack <= Solar Cells + SAR

n Battery + m Solar Packs = PMAD (1W – 100W)

Swedish QuadSat-PnP 1 spacecraft details

- Built by ÅAC Microtec, Uppsala, Sweden
- ”SPA*ready*” (SPA-U / SPA-1), hardware also prepared for SPA-10, SPA-S
- Modular and scalable
- 4U Formfactor , 25 x 25 x 20 cm
- ~15 W continous power
- Weight ~ 15 kg
- Sun Sychronous Orbit, 98.2° inclination
- Orbit height, ~ 700 km
- Orbit time, T ~ 99 min
- Sun pointing stabilized (1 x reaction wheels and magnetorquers)
- Intersatellite, S-band, and VHF data downlink
- Launch target, 2H 2011 on Indian PSLV

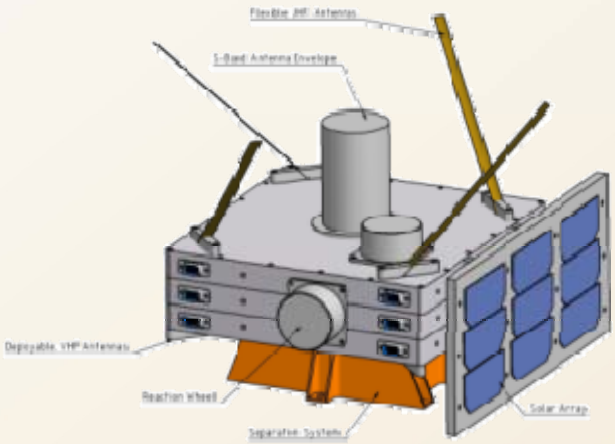
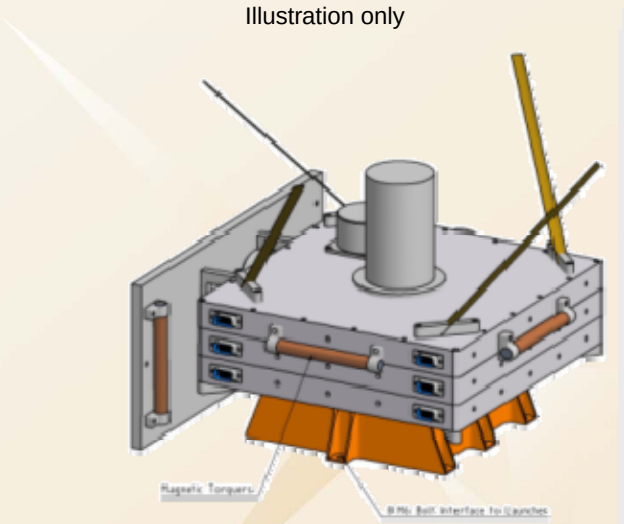
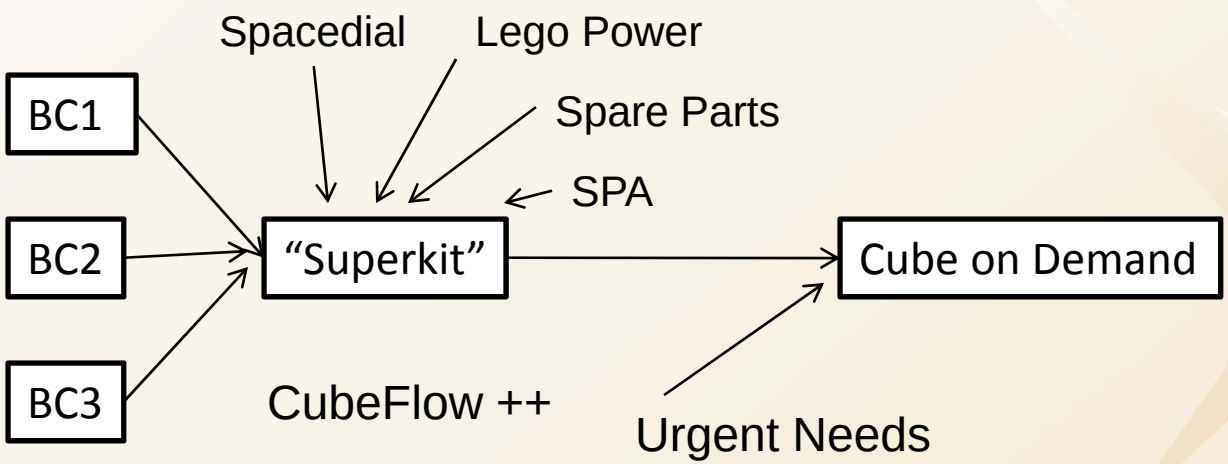


Illustration only



BoreCleaner

- AFRL is building a series of CubeSats called BoreCleaner
- Launches have become more affordable so AFRL is just planning on buying three of them for 3U launches for SPA assets
- What AFRL is desperate for is not folks that can build entire satellites, but that can build single modules (sensor, power, comms) that are SPA compatible



ReSpace 2010 Conference Overview

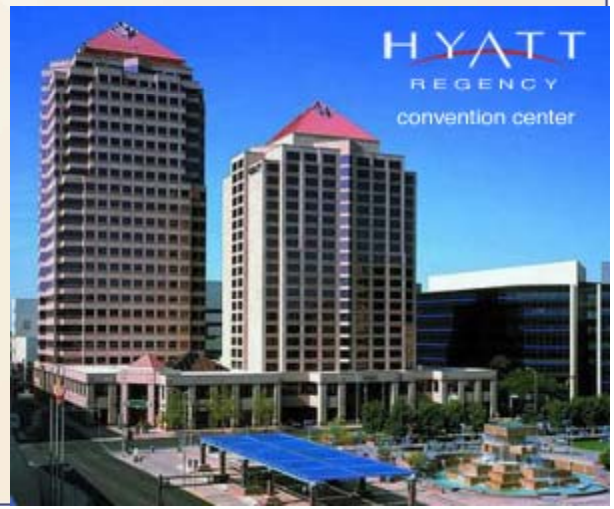
- What commercial electronics components can be effectively used in space systems NOW?
- What does this do to our subsystems – can I make better cameras, IMUs, etc in a small package?
- How does this change missions?

Albuquerque, New Mexico

Come by the COSMIAC booth for the Call for Papers

Dates: 1-4 November 2010

Sponsorship and Exhibitor Opportunities



ReSpace 2010 Conference

- Creative concepts of operation, cost reduction made possible through the use of modern electronics in small spacecraft
- Extending managed space systems capability by introducing reconfigurable electronics
- Doing more with less -- new breed of compact subsystems
- Modularity and Plug-and-Play -- Who's best?
- Responsiveness - "X" on demand (meeting an unexpected requirement quickly)
- State of Modularity for Space PnP: concepts, components, software, tools, etc.
- Current Applications of Modularity - APT, responsive space and current PnP-based launch pipeline activities.
- Revolution after next - Reconfigurable matter, Electro-optical computing, ...
- Outer limits - Using small spacecraft to perform big missions. How far can "small sat" ideas be used to integrate into big concepts, and big spacecraft?

We are looking for papers – CFP has been extended until 1 May 2010

For more information, google: ReSpace 2010 conference