Portland State Aerospace Society

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8 bit to 32 bit microcontroller migration in a CAN-based Open Avionics System

The Portland State Aerospace Society (PSAS) is an educational, open source and open hardware aerospace project at PSU. To our knowledge, we've twice developed the world's most advanced avionics system for an amateur rocket. We're looking to do this for a third time by upgrading our avionics system, a Linux-based x86 flight computer with 5 independent Controller Area Network (CAN) bus nodes.

Project: Upgrade PSAS' existing CAN nodes by migrating them from Microchip PIC microcontrollers (8 bit RISC at 10 MIPS) to ARM7TDMI-based microcontrollers (32 bit RISC at roughly 60 MIPS) and modifying our existing high reliability switching power supply design to handle the new loads and new avionics system power supply. Students will choose a microcontroller, design a "generic" CAN node (including schematic capture, board layout, intensive design reviews), and have the board fabbed commercially. Students will also port a minimal software infrastructure to the node, and measure the node's electrical and computational performance. A secondary goal is to port a full suite of open source tools and operating system to the node.

Expectations: We are looking for students who are up to an embedded systems design challenge. Students should have some experience with embedded systems, schematic capture and board layout, and, if possible, Linux-based software development (for example, using the GNU software development tools). Familiarity with switching power supplies is a plus.

Future of the project: The board designed in this capstone will be used as base design for all of PSAS' application-specific CAN nodes. These nodes include a 6 degree-of-freedom inertial measurement unit, 3D magnetometer, pressure altimeter, multiple temperature sensors, amateur TV broadcast system, and pyrotechnic recovery system.

For more information on PSAS, please see http://psas.pdx.edu/. For detailed information on the PSAS avionics infrastructure, please see http://avionics.psas.pdx.edu/. To discuss this project, please contact Andrew Greenberg at andrew@psas.pdx.edu or 503.788.1343.

Primary Goal: Delivery of an operational ARM7DTMI-based generic CAN node

- Presentation and discussion of board requirements
- Detailed comparison of ARM7TDMI-based microcontrollers
- Selection of microcontroller and design review
- Upgrade switching and backup power supply designs for next generation architecture
- Schematics design review.
- Board layout for a "generic CAN node processor section "
- Layout design review
- Commercial fab of board and student or PSAS stuff of board
- Bring up testing, initial firmware programming
- Measure board performance: power supply, backup supply, and initial microcontroller performance.

Secondary Goal: Port the initial software infrastructure to the new CAN node

- Port the eCos real time operating system to the board
- Demonstrate gdb stubs and open hardware JTAG debugging solution
- Demonstrate reliable communication over CAN with PowerPC flight computer
- Demonstrate firmware upgrade over CAN