Alaskan Sea Ice Buoy Project

Vermont Technical College
April 27, 2009

Project Members

- Dr. Carl Brandon, Team Lead
- Prof. Peter Chapin, Software Developer
- Chad Loseby, Software Developer
- Michael White, Hardware Developer

Outline

- Overview and Background
- Goals and Requirements
- Architecture and Design
- Progress and Future Work
- Feasibility and Duplication

Background

- Researchers at the University of Vermont have been mathematically modeling movement of sea ice in the Arctic
- More data is needed for accurate models
- Vermont Tech was approached to help collect data

Background

- VTC's Aeronautical Engineering Technology program also wanted to gain experience with space technologies and devices
- CubeSat Kit platform available and well suited to task

The Buoy

- Sits on floating sea ice
- Collects environmental data
- Relays data back to Vermont

Goals & Requirements

- Requirements include collecting:
  - Wind speed
  - Absolute wind direction
  - Temperature
  - Location (latitude and longitude)
- Approximately every 15 minutes

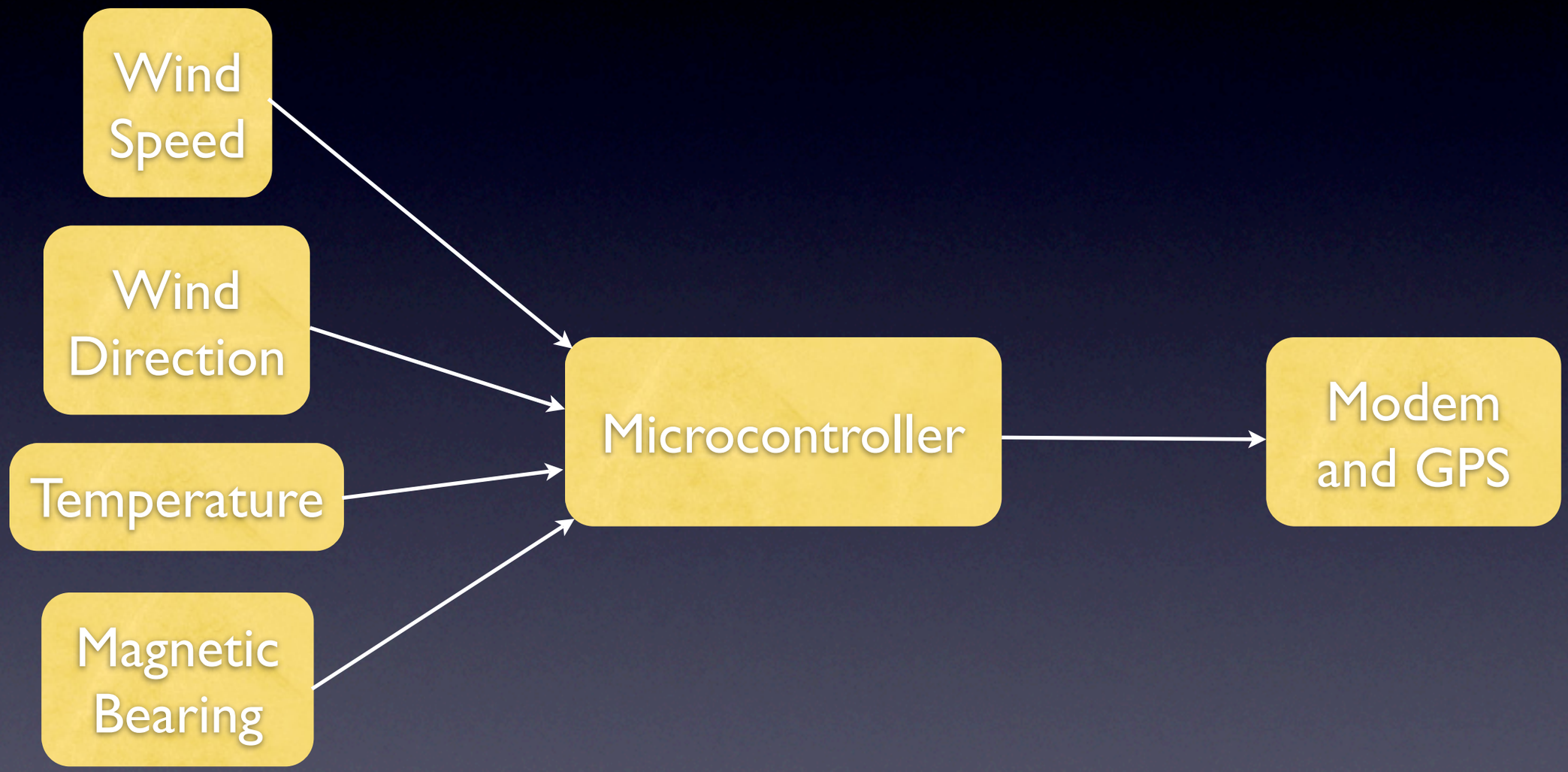
Goals & Requirements

- Data must be transmitted back to Vermont in a reasonable timeframe
- Buoy must be fault tolerant and capable of running for several months in harsh climate
- Prototype must be designed to be easily duplicated

Top Level Design

- The buoy will consist of:
  - Environmental sensors
  - Microcontroller
  - Satellite Modem
  - Battery
  - Enclosure

Top Level Design

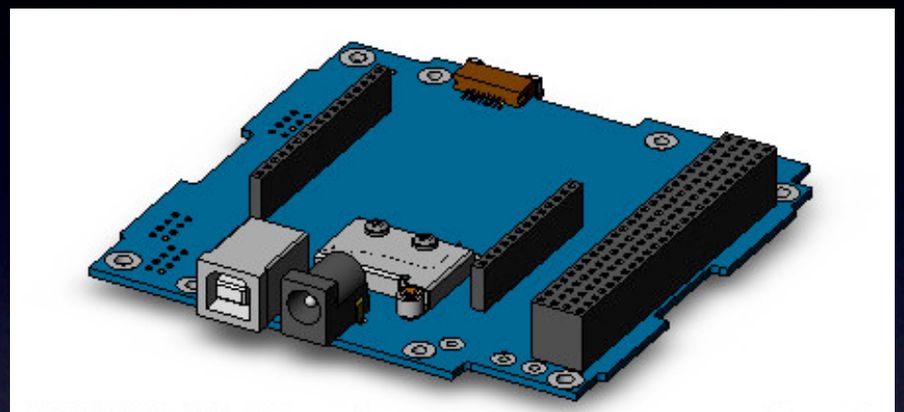


Hardware Specifics

- NRG Systems wind vane, anemometer, temperature sensor
- Honeywell 3-axis magnetometer
- CubeSat Kit Flight Module (TI MSP430)
- NAL Research Iridium Modem and GPS
- Lithium Thionyl Chloride battery

Hardware Specifics

- CubeSat Kit Flight Module handles all computational needs
- Texas Instruments MSP430 low power microcontroller onboard



- Consumes 2μA while sleeping, 340μA while awake at 3.3V

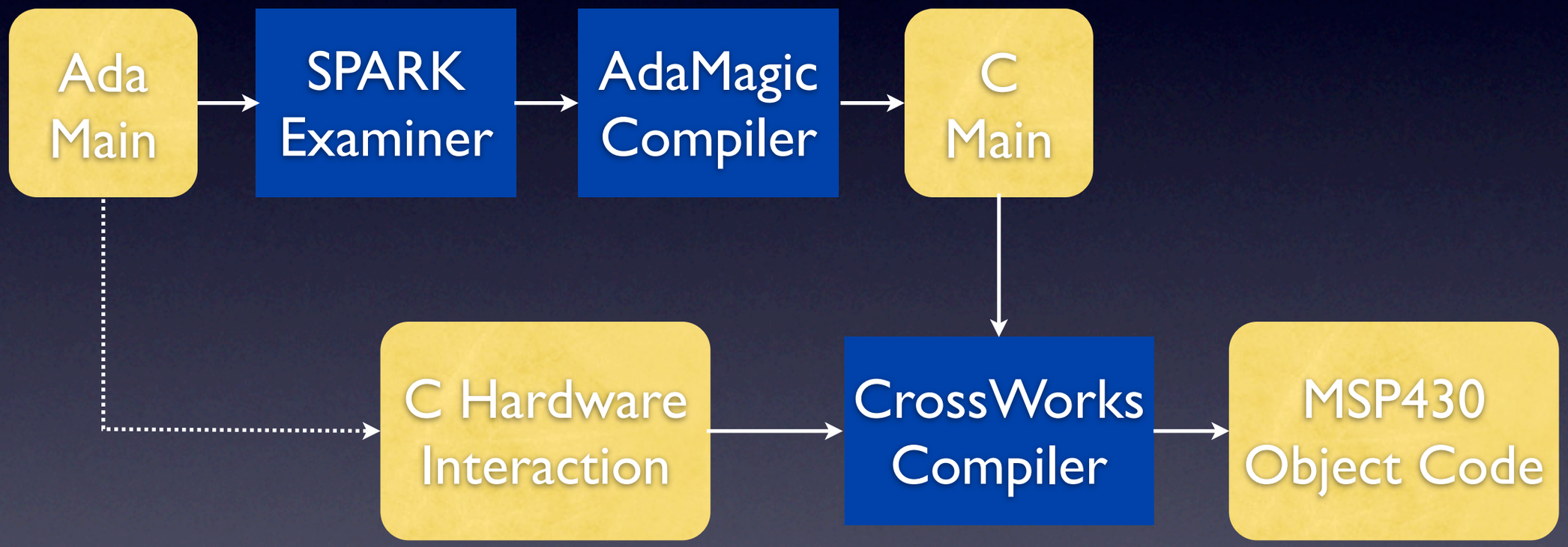
Hardware Specifics

- NAL Research 9601-DGS-LP combines an Iridium satellite modem and a global positioning (GPS) unit
- The Iridium network's constellation of 66 low orbit satellites, in combination with the modem, allows the buoy to send short messages from anywhere on Earth

Software Architecture

- SPARK, a strict subset of the Ada programming language, was chosen
  - Strongly typed
  - Potentially dangerous features removed
  - Integrity examined and evaluated
- No Ada compiler exists for our platform

Software Architecture



Progress

- Initial goals were lofty
- “End-to-end data flow” achieved
  - Wind direction and temperature read
  - Data flows through microcontroller
  - Transmitted via modem
  - Buoy goes back to sleep

Future Work

- Software:
  - Read and transmit wind speed, magnetic bearing, GPS data
  - Fully implement buffering
  - Create server-side software to handle data

Future Work

- Hardware:
  - Connect magnetometer
  - Construct an appropriate enclosure
  - Design permanent circuitry to better integrate sensors, flight module, modem, and battery

Feasibility, Duplication

- Remaining work very feasible
- Software and hardware costs may be prohibitive
- Work so far easily duplicatable to construct many buoys

Questions?