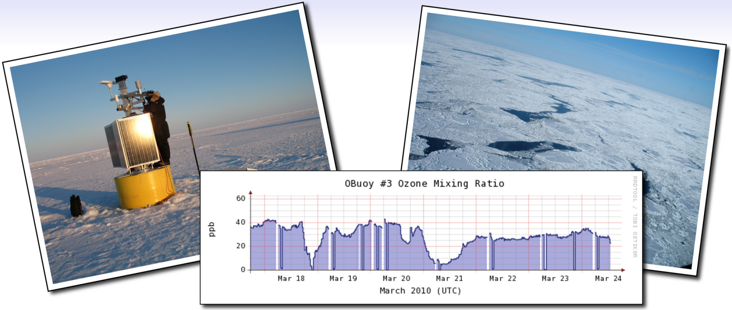
OBuoy
An Autonomous Sea-Ice Tethered Instrument Platform

Dr. Todd Valentic

Center for Geospace Studies
SRI International

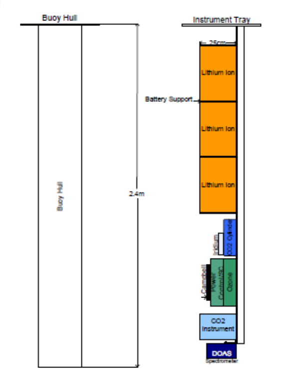
Polar Technology Conference
March 25–26, 2010

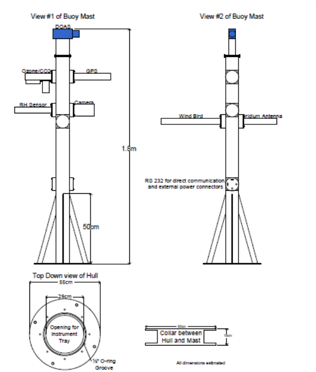
Introduction



- Ocean / atmosphere / sea ice / snow pack interactions
- Ozone depletion events
- Very few continuous measurements of O3, CO2 and BrO
- Platform for chemistry sensors, unattended for one year
- Purdue, Bigelow, CRREL, MBARI, SRI, UAF, Environment Canada

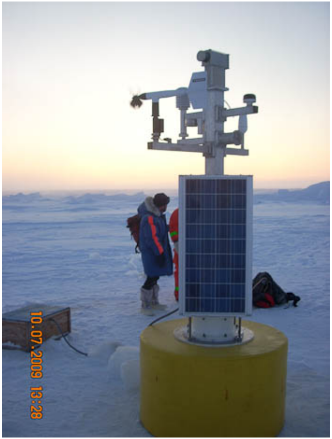
OBuoy Hardware





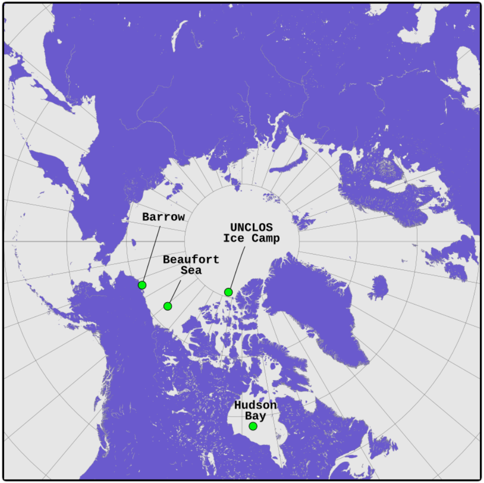
- Lithium primary batteries
- Calibration gas cylinders
- AGM rechargeable batteries
- Solar panels (4x50W)

OBuoy Instrumentation



- MAX-DOAS
- CO2 sensor (LI-COR)
- O3 sensor (2B Technologies)
- Meteorological (RM Young/Vaisala)
- GPS compass (Hemisphere V100)
- Power monitoring (CR-1000 data logger)
- Iridium (AL3A-X)
- Webcam (Logitech Vision Pro)
- Computer (TS-7260)

Deployments



Mark I to Mark II Design

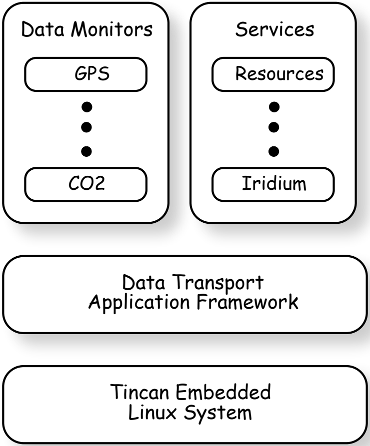
- Worked good, but power hungry
- Reduce and manage computer resources
- More flexible scheduling
- Scaling and production considerations
- Resulted in major software redesign

Low Power Operations With The TS-7260

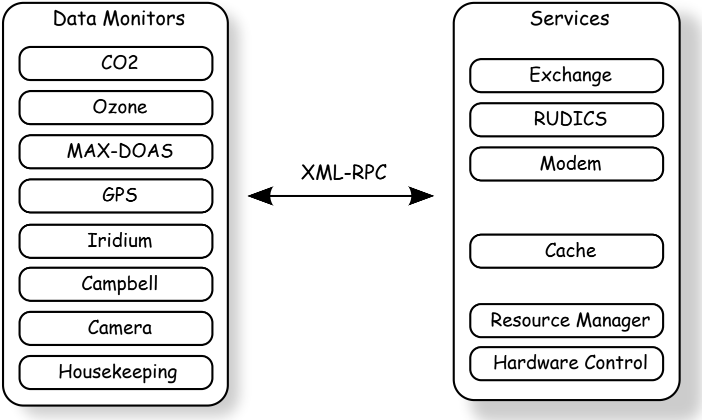
- Consolidate comms and supervisory computers
- Ability to turn off USB, Ethernet, UART, LEDs
- Scale CPU clock frequency 14MHz–200MHz

Normal, everything on	5V	220mA	1.1W
Ethernet off	5V	120mA	0.6W
UART off	5V	220mA	1.1W
CPU 166MHz	5V	190mA	0.95W
CPU 42MHz	5V	170mA	0.85W
CPU 14MHz	5V	150mA	0.75W
Ethernet off, CPU 14MHz	5V	50mA	0.25W

System Architecture



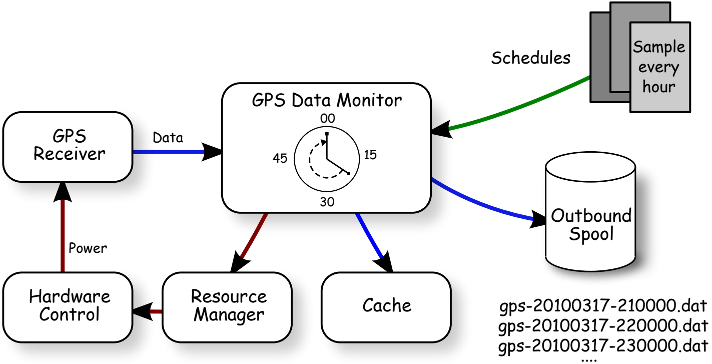
Application Components



Data Monitor Components

Framework Component for Periodic Tasks

- Resource management interface
- Output file handling (i.e., hourly, compressed)
- Reloadable schedules



Resource Manager

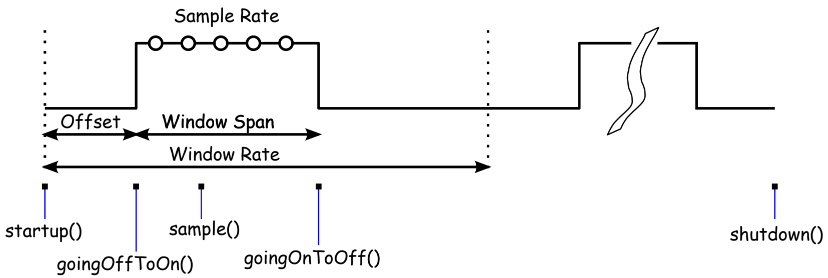
Control Device Power and Data Buses

Resources

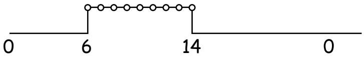
	USB	PC104	ETH	DIO1	DIO2	CPU	Battery
CO2				6			
O3							
DOAS			●	5		42	
GPS		●		7			
Iridium		●		3		200	
Campbell				2			
Camera							
Background						42	
Manual							
Current State		●	●	2,3,5,6,7		200	

Scheduling

Sample Periodically During Collection Window



sample.rate: 1:00:00
window.rate: 1 day
window.offset: 6:00:00
window.span: 8:00:00



Multiple Schedules

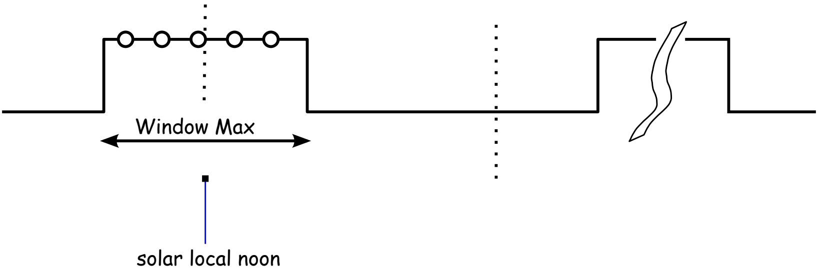
Seasonal Schedule

```
[DEFAULT]
priority:        10
time.span:       months=3
repeat.days:     1
sample.rate:     10:00

[Winter]
time.start:      December
window.span:     2:00:00

[Spring]
time.start:      March
window.span:     10:00:00

[Summer]
time.start:      June
window.span:     20:00:00

[Fall]
time.start:      September
```

Campaign

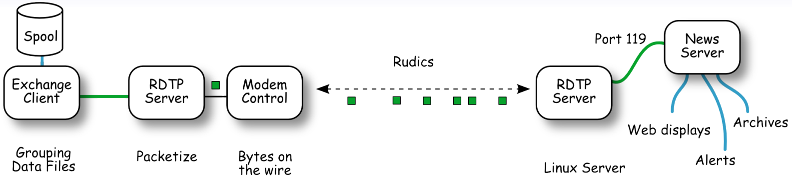
```
[HighRes]

time.start:      2010-04-03 12:00:00
time.stop:       2010-04-10
window.span:     24:00:00
sample.rate:     1:00
priority:        50
```

Pluggable Schedule Algorithms



- Window centered around solar local noon
- Actual times computed based on GPS
- Modulated by sun being up
- Extend to other scenarios (i.e., night only)

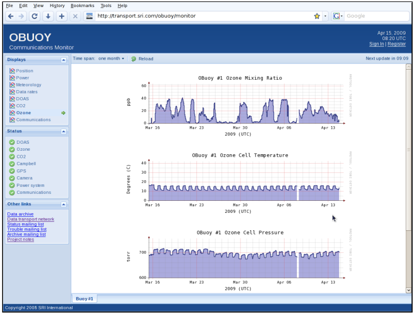
Data Transfer via Iridium/RUDICS



- Periodic data transfers (6 hours)
- Files are moved to the outgoing spool
- Small files are combined, large ones split (15KB chunks)
- Call retry if connection dropped
- Transfers are resumed at last 15KB chunk
- Bidirectional
- Over-the-air code updates

Real-time Displays and Post-Processing

- Science data plots
- Health and system status
- Email alerts
- Virtual observatories (CADIS)
- Scale for all buoys



Software Updates

- Important to get right
- Software configuration management
- Test on live hardware
- Develop a process
- Tarballs, standard install scripts, etc

Failsafes

- Hardware circuits select battery source
- Hardware watchdog to reboot SBC
- Software watchdog if no contact in a day
- Listen period - power on Iridium, PPP dialin

More Information

- Iridium and RUDICS
- Data Transport Network
- Real-time displays
- Tincan linux
- Copies of presentations

todd.valentic@sri.com
http://transport.sri.com
http://transport.sri.com/rudics