Advances in Remote Seismic Station Technology

IRIS PASSCAL POLAR PROGRAM

NSF IRIS

NEW MEXICO TECH
SCIENCE · ENGINEERING · RESEARCH · UNIVERSITY

Contents

* Telemetry
  - RUDICS
  - XI-202 SBD Only Modem
* Power Systems
  - Wind Powered Heater
  - Lampshade Solar Re-design
  - Rechargeable Lithium Batteries

RUDICS

Router-Based
Unrestricted
Digital
Internet-working
Connectivity
Solutions

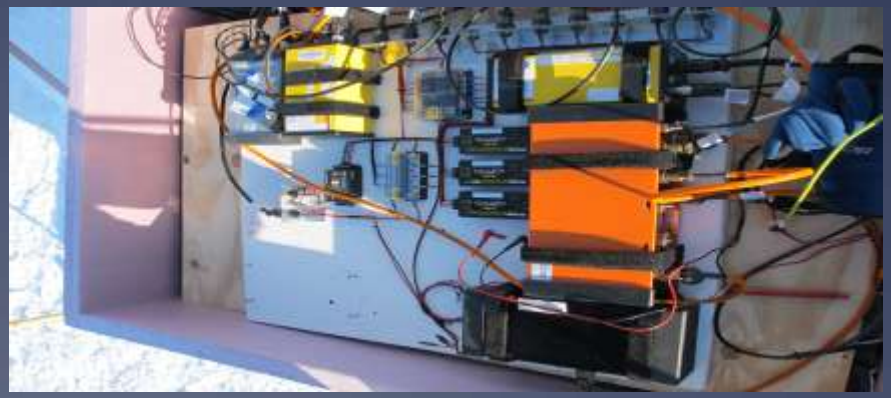
A SLOW 2400 BAUD Ethernet connection which allows remote:

1. Collection of Quasi-Real-Time, low sample rate data.
2. Instrumentation command, control and high resolution SOH monitoring.

RUDICS in Greenland

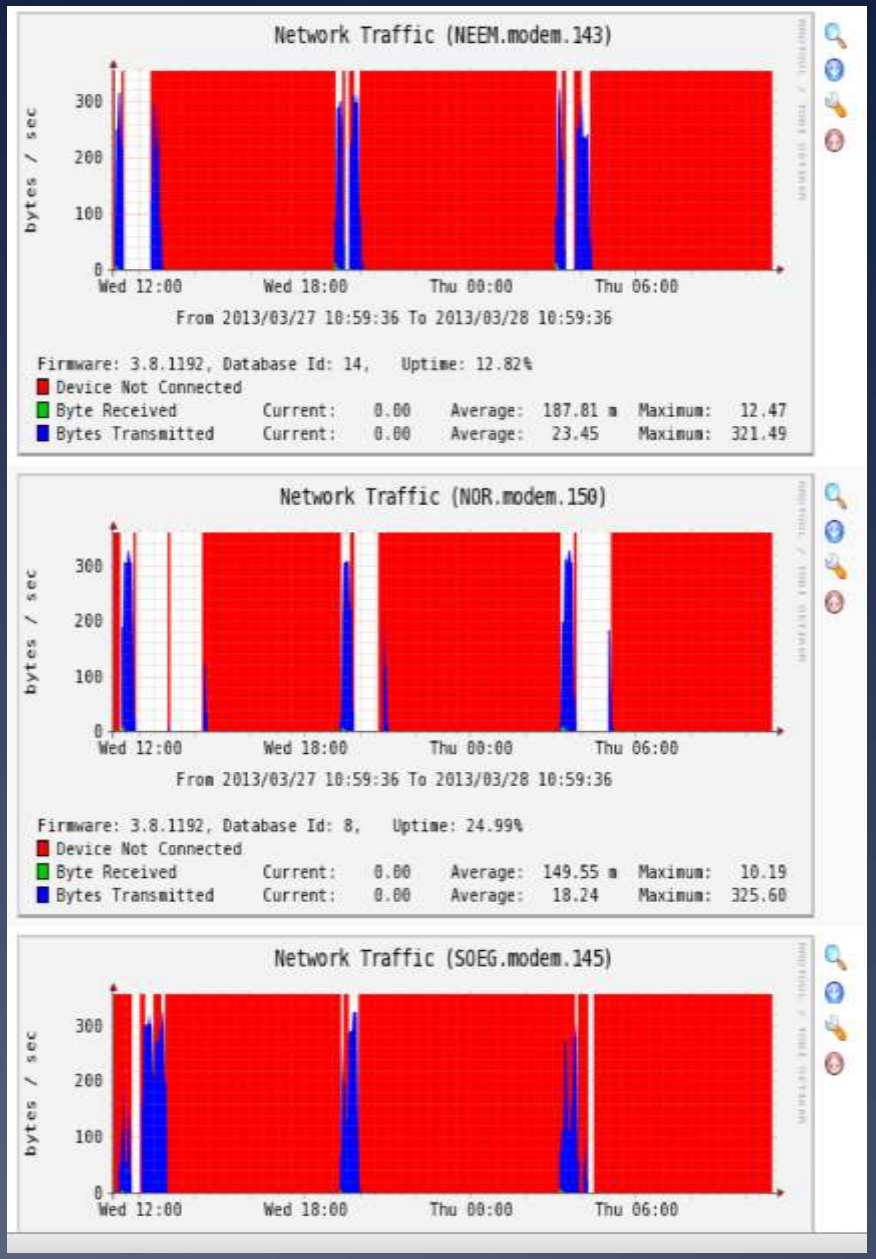
* Since 2011 PASSCAL has installed 11 year round operational *RUDICS* telemetered stations of which 6 are installed on the Greenland Ice-Cap.

* From servers at ***UNAVCO*** and ***PASSCAL*** 1-3 Mb of data per day is recovered from each station. This includes a transmit byte overhead ranging from ~16-20 %. Data recovery is near 100% and piped directly to the IRIS Data Management Center for immediate access by the Scientific community.



RUDICS Specs

* The Iridium modem used is the ***XEOS XI-100B*** which draws a peak ~5 watts in full transmit mode and sleeps at 6 mW.
* *RUDICS* Data download rate peaks at ~300 Bytes/s.
* Current modem Tx on time for the seismic stations range from 2-3 hours/day requiring 0.8 to 1.25 Ah of battery power. In this mode a station requires a 50% increase in battery bank size over the standard iridium SOH-only telemetry.
* Current battery banks at the autonomously powered stations range from 1400 to 8000 Ah. The larger battery banks were designed to support full time 24hr/day *RUDICS* with multiple instrument packages.

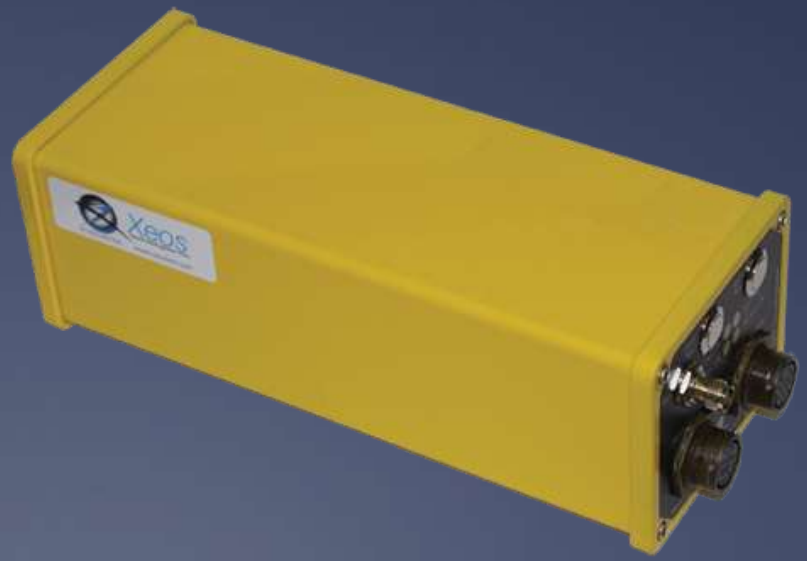


Current *RUDICS* Testing

* Testing Real-Time data collection from the Q330 digitizer using both *Antelope* and *Pecos* software packages. We have reliably shown we can can maintain over RUDICS three channels at 20 sps using *PECOS*.

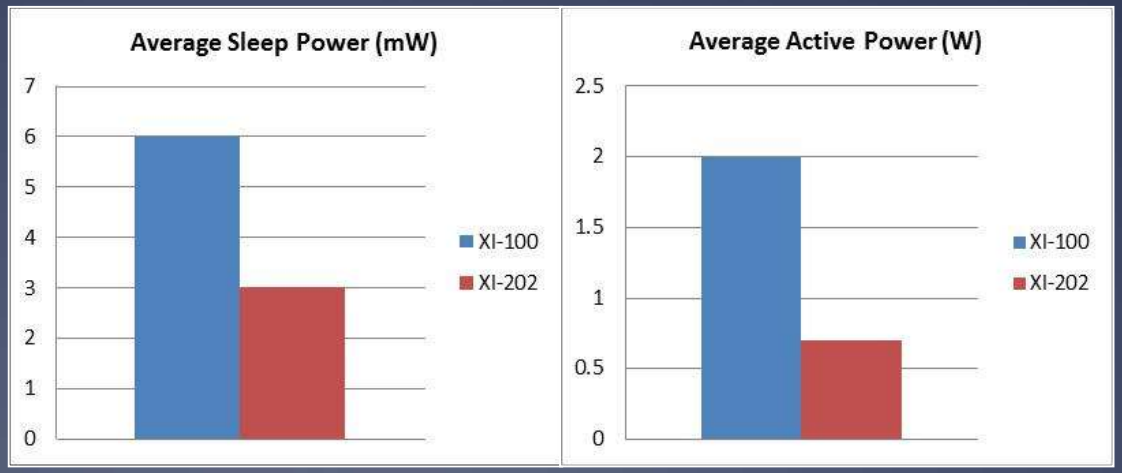
* Characterizing using *Lab-View* software the total daily power consumption of different RUDICS transmission and hardware configurations.

* Developing schemes for single event higher sample rate downloads.



XI-202
Xeos Technologies Inc.

* SIM-less, SBD Only modem
* Low impact, low power solution for reliable state of health (SOH) data.
* Benefits Compared to XI-100:
  - Reduced Size
  - Reduced Power Consumption



XI-202's In the Field

* Currently Installed:
  - 2 stations in Antarctica
  - 1 Station in Alaska
* 2013-2014 Installations:
  - 5 planned installations in Greenland
  - 15+ planned installations in Antarctica

Easy (and fun!) to install

XI-202 installed at ICE-Z site on Mt. Erabus

Wind Powered Heater

Charge Controller

LVD

Self Thermo-regulated heat Pad

AGM 34 Ah

* Used at extremely cold sites on the Antarctic plateu where digitizer ossiclator failures occur.

Low Power Wind Turbine with Ceramic Bearings

* Rutland 504e
  - Weight: ~4 Kg
  - Blade diameter: 50 cm
  - Startup wind speed: ~6-7 Kts
  - 3W @ 10 Kts; 24W @ 22 Kts; 44W @ 30 Kts
  - Cost: ~$550 (504), ~$650 (504e)
  - In retrospect, we would not use the eFurl option because of the large electrolitic caps in the turbine head (likely to fail in the extreme cold)

Dry Ceramic Bearings

* Blade diameter is small → Small increase in friction = large increase in startup wind speed, AND wind speed typically low on Plateau,

  ∴ Need for minimum friction

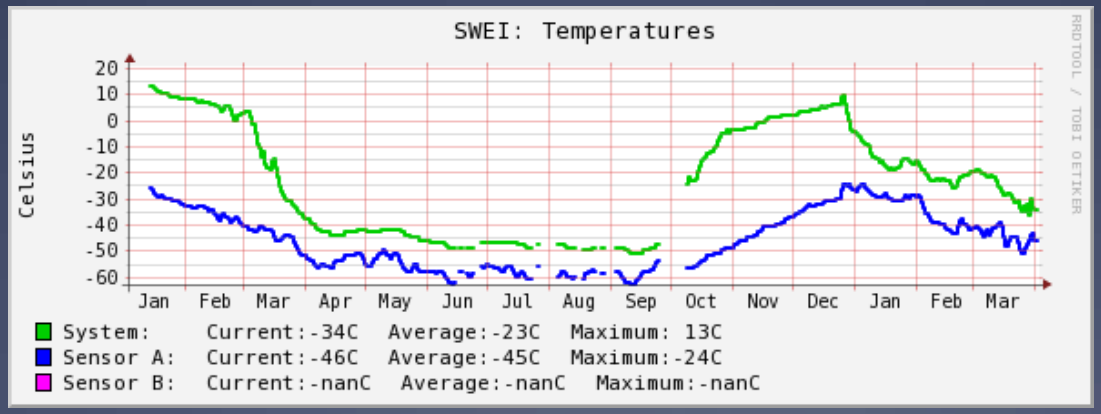
* Solution: Use of bearings without lubricant (very low friction) → Have to use ceramic bearings.

* We used bearings from Bearing Tech Inc. http://www.precisionbearings.net/

* Cost: ~ 5 x cost of regular bearings.

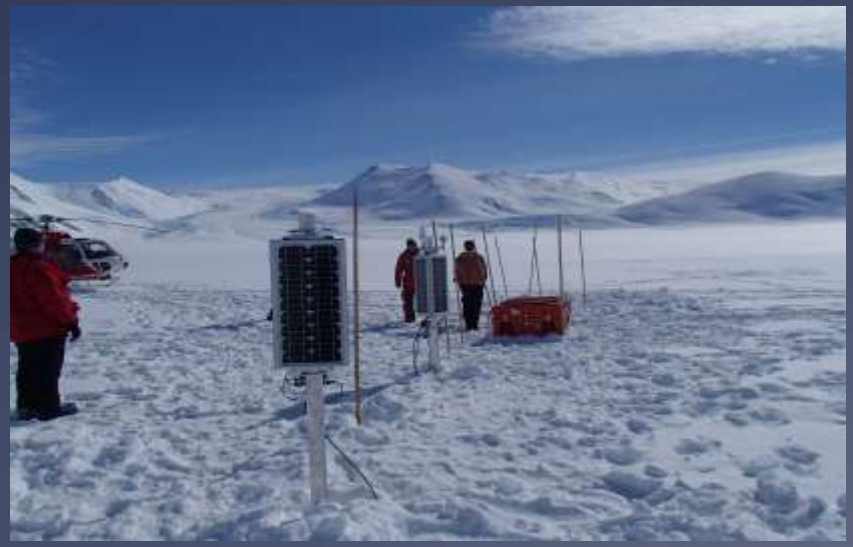
Results

- It was installed at end of December. So far, providing ΔT > 10°C about 75% of the time, in addition to ΔT generated by the equipment.
- A 34 Ah AGM is the largest battery that would fit in the enclosure. With low temperature de-rating, it provides 3 to 4 days of heat between wind events.
- As of 21 March, it has worked well whenever the wind is up.



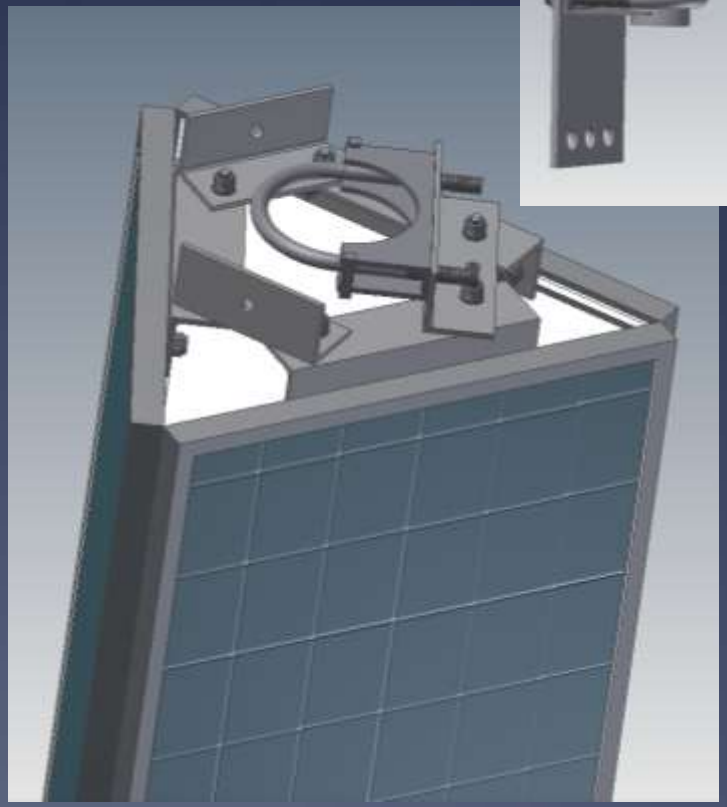
Lampshade Solar Redesign

* Designed to take advantage of 24hr daylight in Polar regions
* Rapid Deployment
* Easily raised and modular



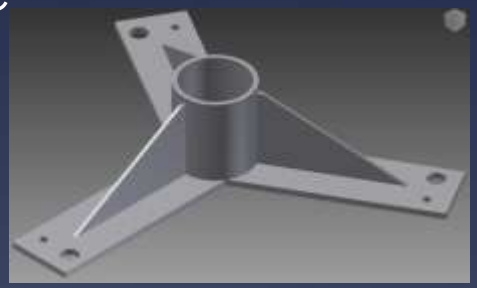
Disadvantages

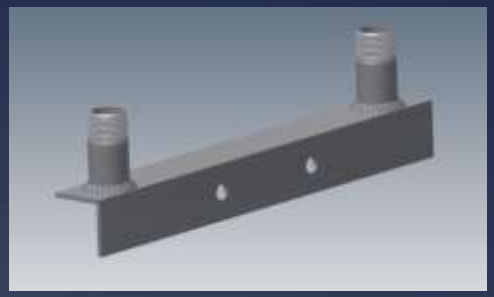
* Lots of hardware
* Long assembly time
* Weak base
* Accommodates only 1 type of panel

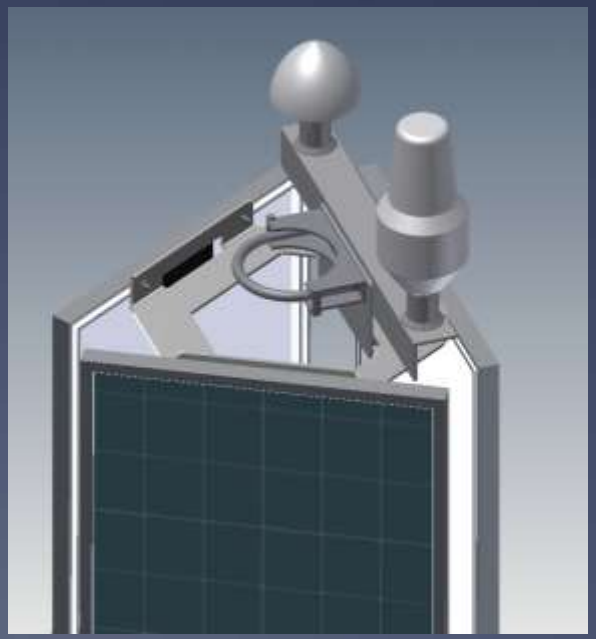


New Design

* 1 piece panel mount
* Can accommodate multiple panel models
* Stronger base
* Simpler antenna mount

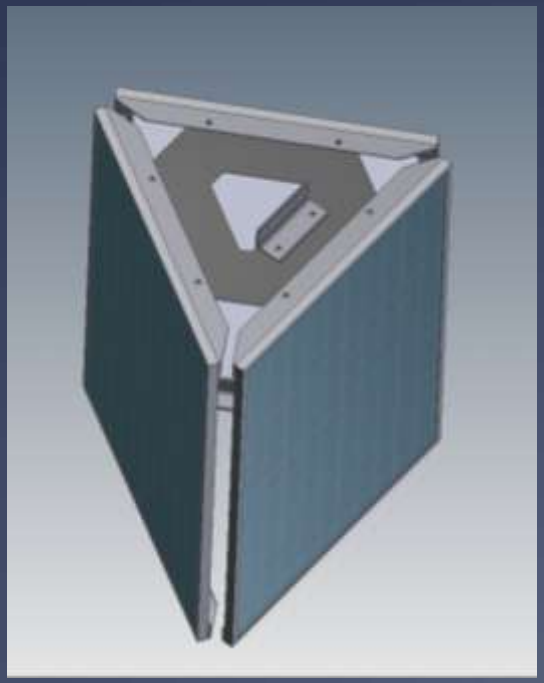






Future Development

* Scaled up design using larger panels
* Possibility of custom panels, thin film…



Rechargeable Lithium Batteries

- Characterization Testing on small strings
  - Capacity de-rate at Polar temps
  - Cold temp effect on lifespan
  - BMS functionality at cold temps
- Battery Management System (BMS) Standard
  - Power System Monitoring with data output
  - String Isolation, remove failed cells
  - Heating systems
- More Energy per Weight and Volume
  - 2x Gravimetic Power Density
  - 1.27x Volumetric Power Density
    - Reduced logistics cost
    - Increased opportunity

5 kWh Marine Li Battery

240 Wh BDI Battery

Questions?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