Polar Technology: Power & Communications Options

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Presentation Overview

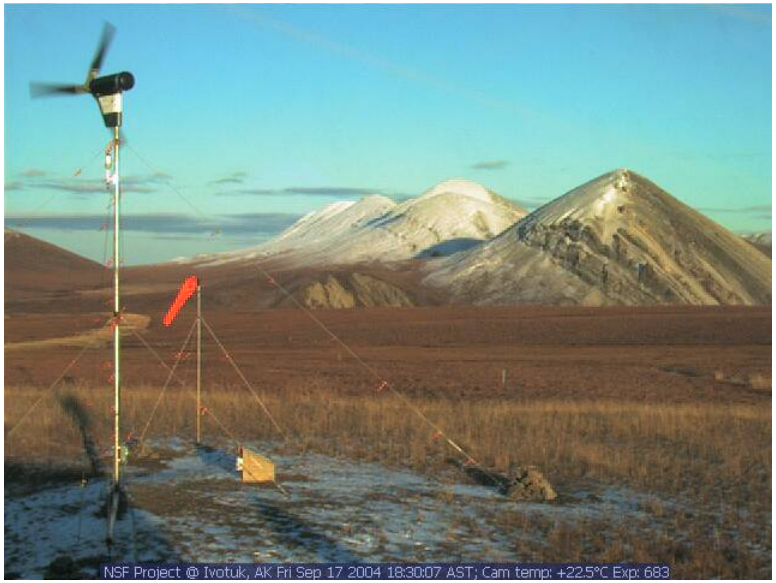
- **Iridium Network loss of registration**
- **Webcams**
- **The Data Transport Network**
- **7th Annual Clean Snowmobile Challenge**
- **PolarPower.Org Website**
- **NSF's Arctic Logistics Support**

Iridium Network Loss of Registration

- **Remote units that don't initiate a call are "lost" by the network**
  - **SRI's remote commercial unit showing "Busy"**
- **1 Feb 2006 "PIL" procedure to force all DoD units to re-register**
  - **NOAA recovered 9 of 11 units as a result**
  - **Logistically too complex to be done for commercial units**
- **Remote unit must force a registration**
  - **Power cycling**
  - **AT+COPS=1**
- **MPT option from NAL Research**
  - **Developed for Raytheon Polar Services**
  - **Microcontroller senses transceiver state**
  - **Optional retrofit to 9522 LBTs**

StarDot Technologies Netcam

- **Rugged design**
- **Internal Web & FTP servers**
- **Standard: 640 x 480 max**
  Megapixel: 1280 x 960 max



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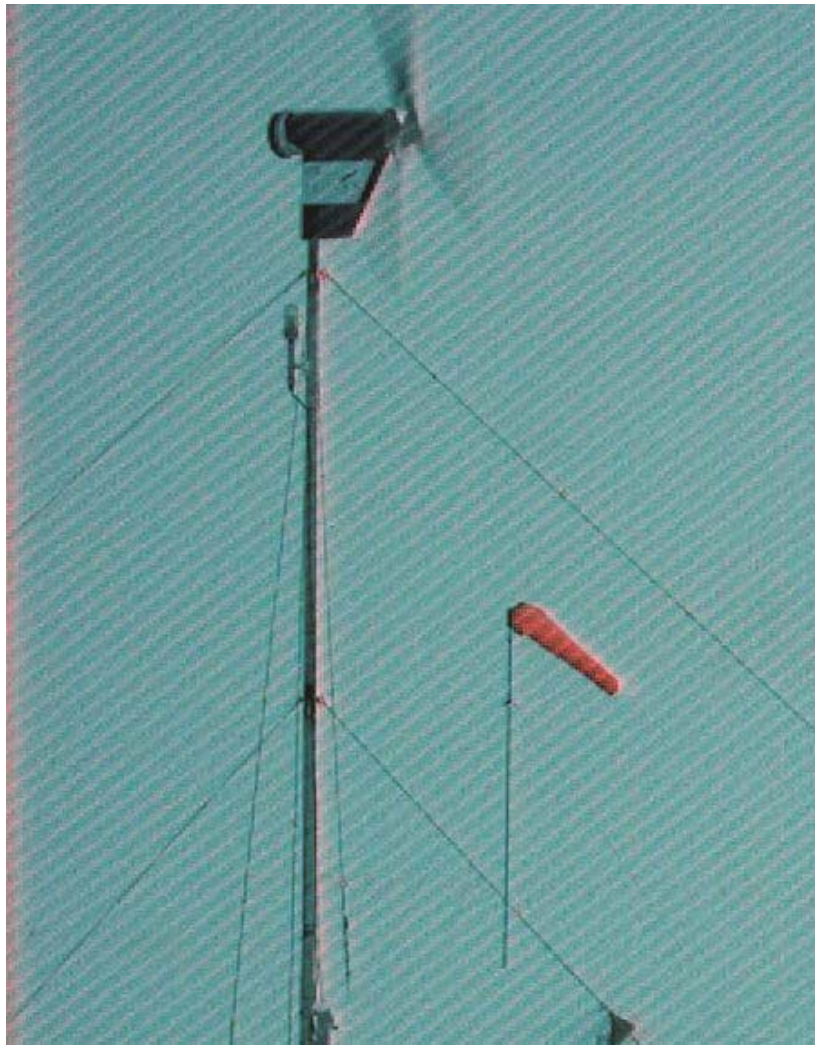
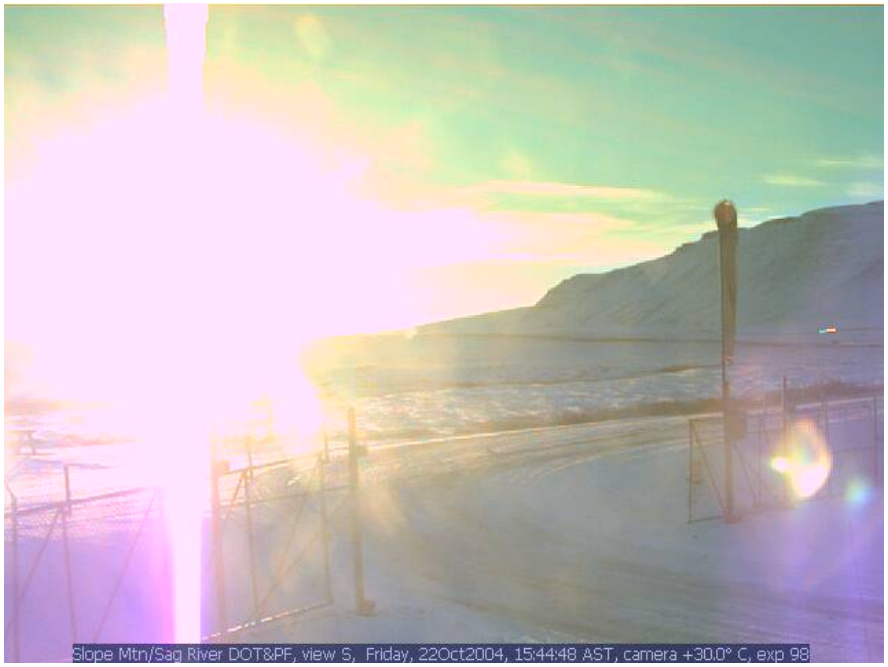
Netcam MP Problems

- **Internal DC/DC converters will lock to others causing power supply ripple that is visible in the image**
  - **MP CCD is very susceptible to noise on negative supply**
  - **Requires addition of additional capacitors (1000 µF)**
  - **“Only happens at remote locations”**
- **Red blooming in bright sun**



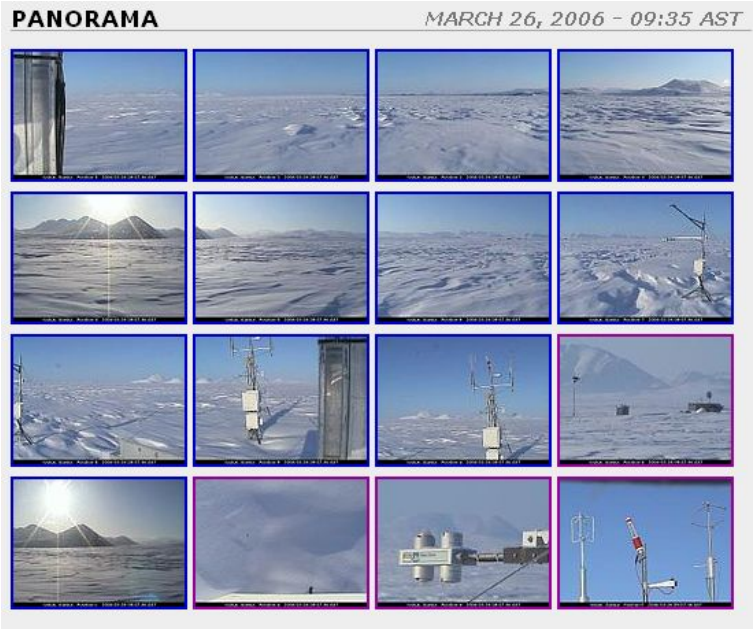
StarDot Technologies Netcam (Cont'd)

- **Robust sensor resists burning with direct view of the sun**
  - **Any polar deployment will view the sun during some part of the year**
  - **Gradual burning of red solar arcs**
- **Internal Boa Web server hangs on StarBand (long delay) links**
- **Slow exposure adaptation**



Webcam Deployment at Ivotuk, Alaska

- **Sony SNC-RZ-30N**
  - **640 x 480 pixel image**
  - **PTZ control**
  - **~7 Watts**
  - **SD Memory & WLAN Slot**
- **Continuous operation**
  - **10-min update of default image**
  - **30-min, 16-frame schedule**
- **“Sunburn-tolerant” sensor**
  - **Good sensitivity (B&W aurora)**
- **Protocol failures at -20 °C**
  - **Power cycling of unit**
- **Servers can’t tolerate satellite delay**
  - **Local protocol buffering**



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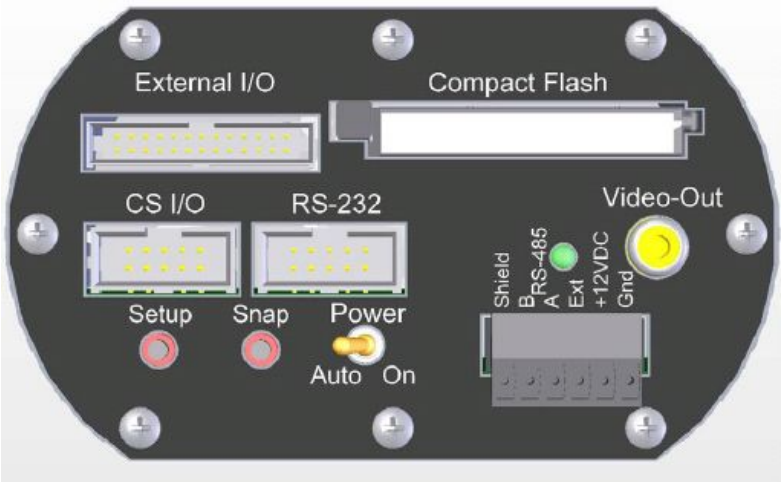
Rime Icing at Ivotuk, Alaska

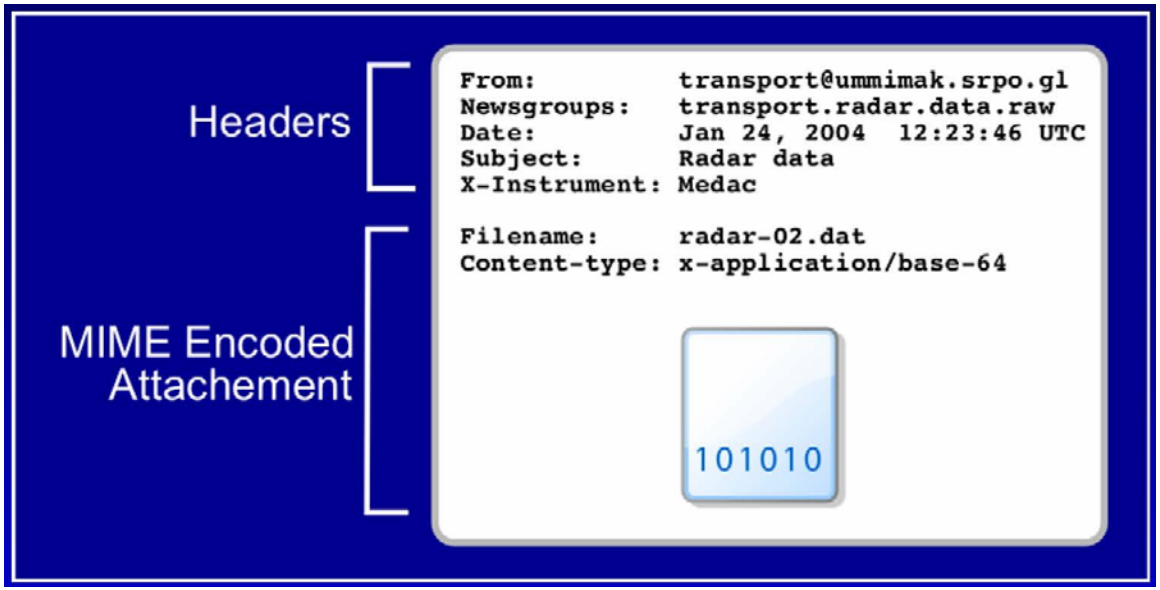
- **Limited power availability**
- **Large viewing area for PTZ Webcam**
- **Techniques under consideration**
  - **Smoother housing**
  - **Closer thermal coupling of heater to housing**
  - **Inflatable bladder at mid-point**
  - **Alcohol mister**

Campbell Scientific Inc. CC640 Digital Camera

- 640 x 480 pixel JPEG image (640 x 504 pixels w/ timestamp)
- 9-15 VDC @ 250 mA (250 uA quiescent current)
- - 40 to +70 ° C operating temperature range
- Compact Flash memory (512 MB max.)
- Interface
  - RS-232 or RS-485
  - CS I/O

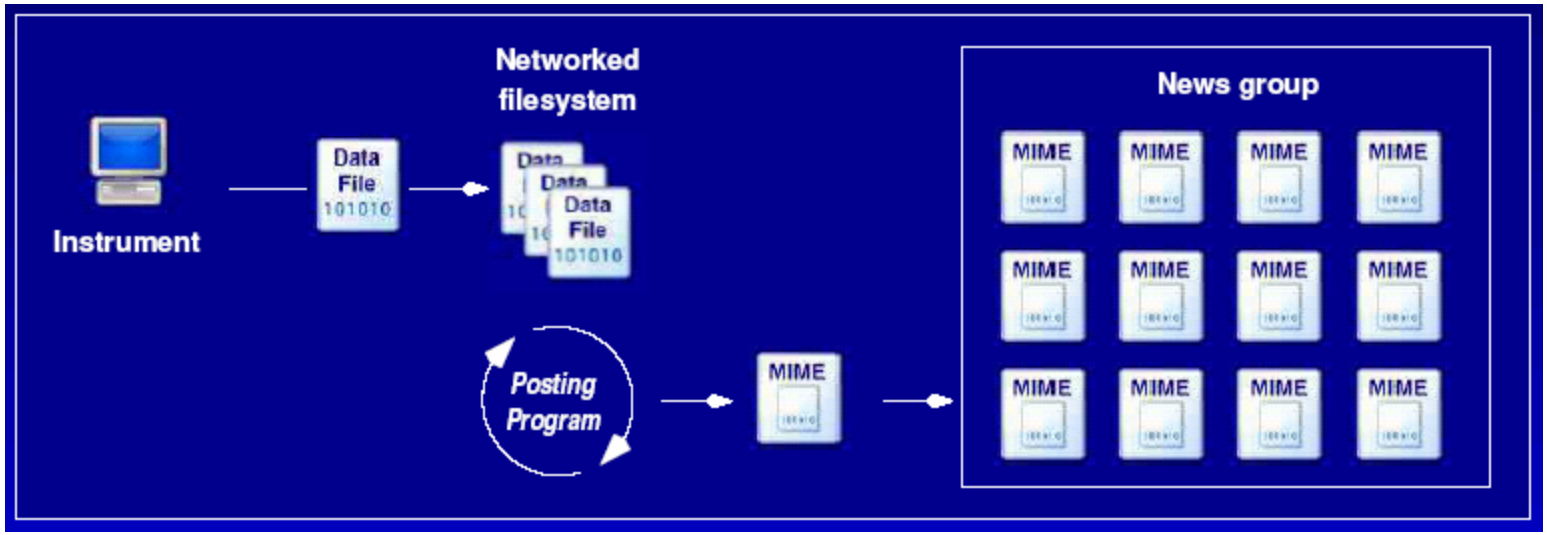


The Data Transport Network



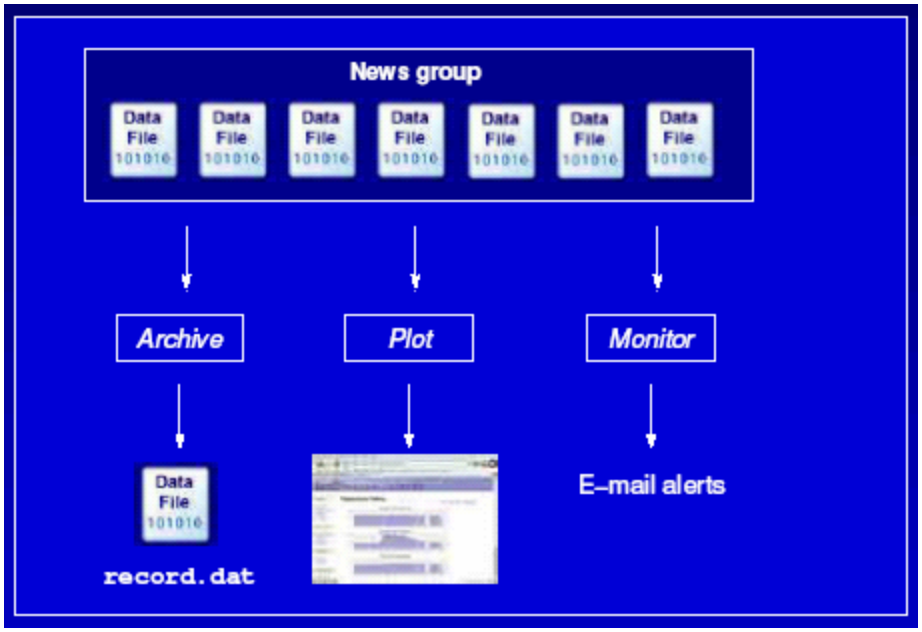
- **Data transfers as Usenet message attachments**
- **Well developed protocols for reliable message transfer over a wide variety of networks**
- **Headers provide the metadata; content can be any type of data**

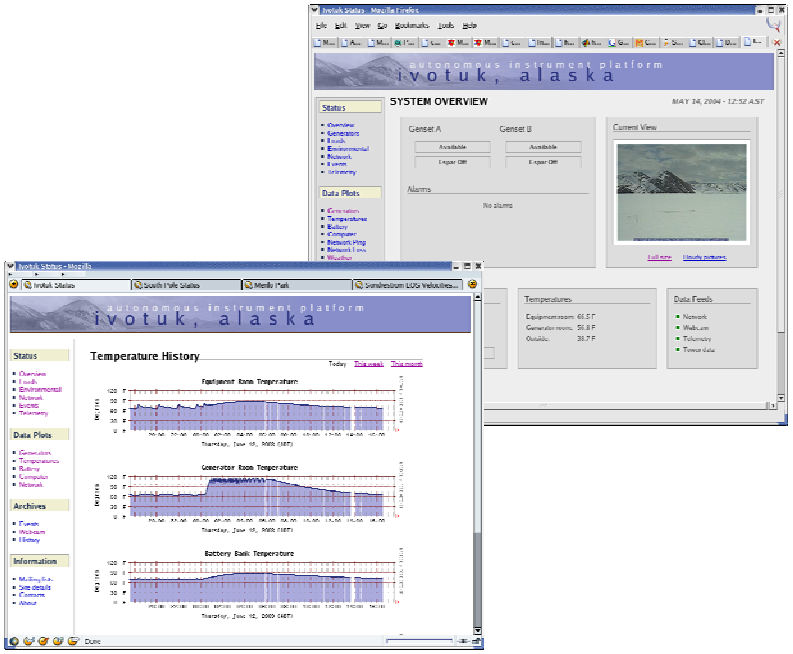
Newsgroup Message Queue



- Remote device writes data files to shared network folder
- Posting program encodes data into message format
- Newsgroup acts as a queue to hold messages
  - Multiple newsgroups can be handled

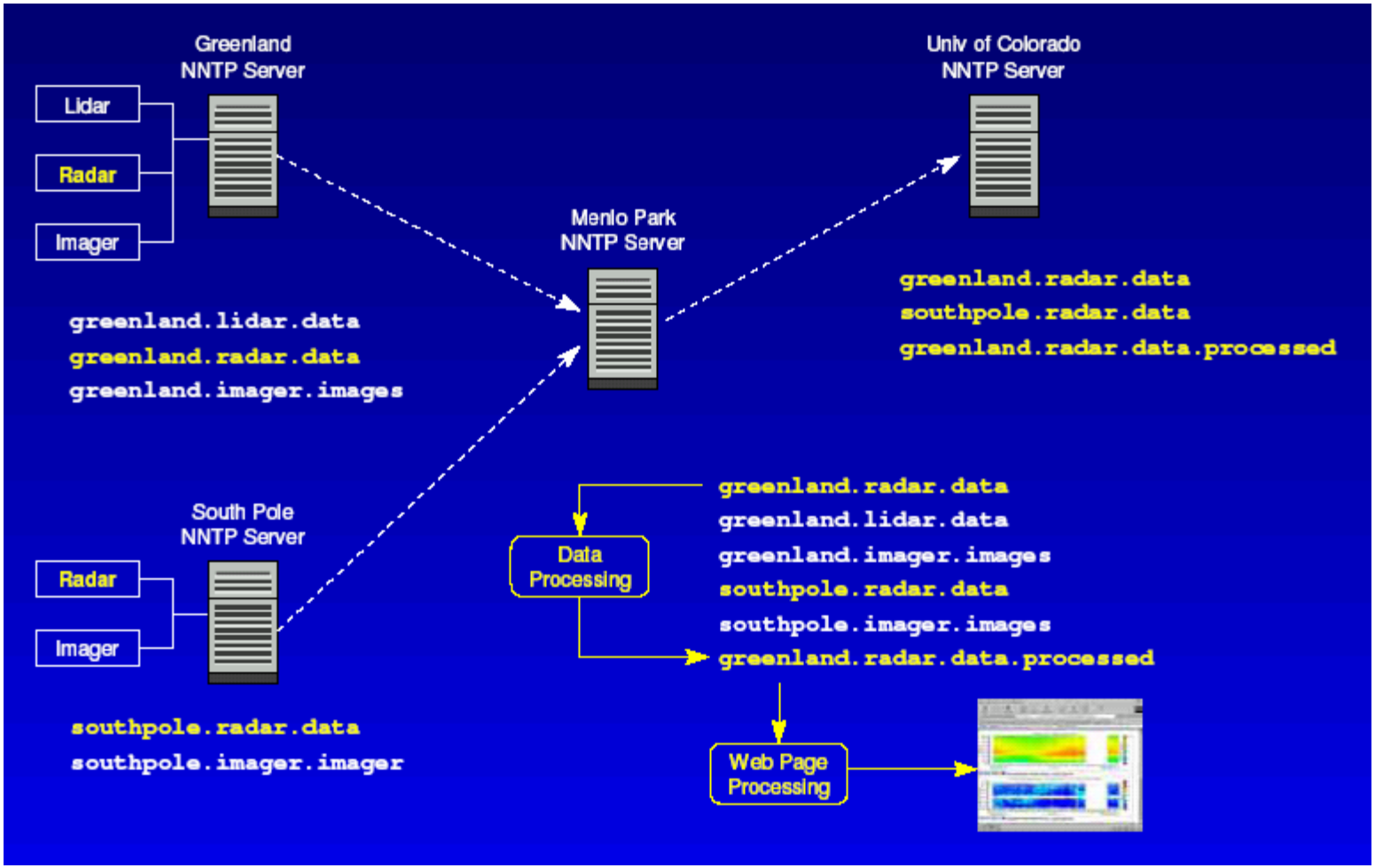
Newsgroup Publication and Subscription





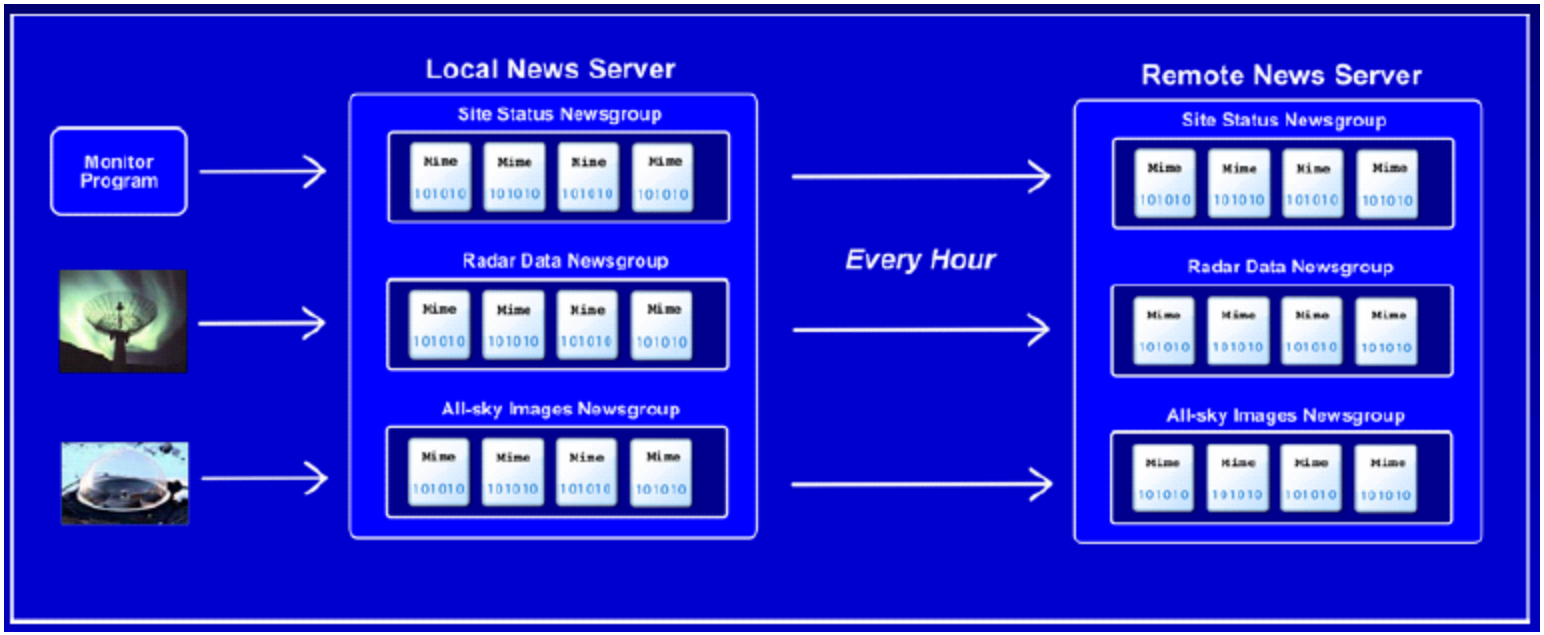
- One producer, many consumers (i.e., marketplace)
- Short-term history with automatic expiration
- Data interpretation for quick-look display
- Status monitor with distribution of Alerts through e-mail distribution

Multisite Data Processing



- **Other sites can process data and post their results**

Distribution to Remote News Servers



- **Periodic replication of data to one or more remote servers (e.g., research organizations)**
- **Local file access, with access controls; avoids Internet delays**
- **Automated archival**

Uploading of Instrument Commands and Schedule

- **The newsgroup distribution is reciprocal**
  - **The remote instrumentation site can subscribe to a "Command" newsgroup**
  - **Command files can set a measurement and reporting schedule**
- **Typical process scheduling has Command upload occur before data downloads**
  - **Operational schedule usually of highest priority**
  - **Command files are typically small**

Magnetometer Array for Cusp and Cleft Studies (MACCS)

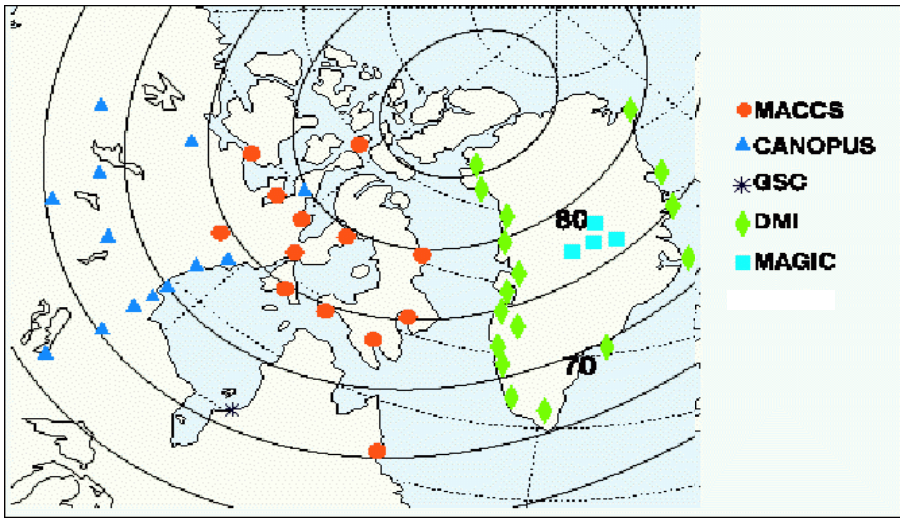
- **Distributed Iridium-communicating sensor network**
  - **2 Remote stations per Master polling station**
  - **10-minute polling interval**
  - **~30% of cycle available for abnormal condition handling**
  - **~3 Mbytes/station/day of data in compressed form**

Remote Stations:

- **Data collection**
- **Archival to CD**
- **Health and status**

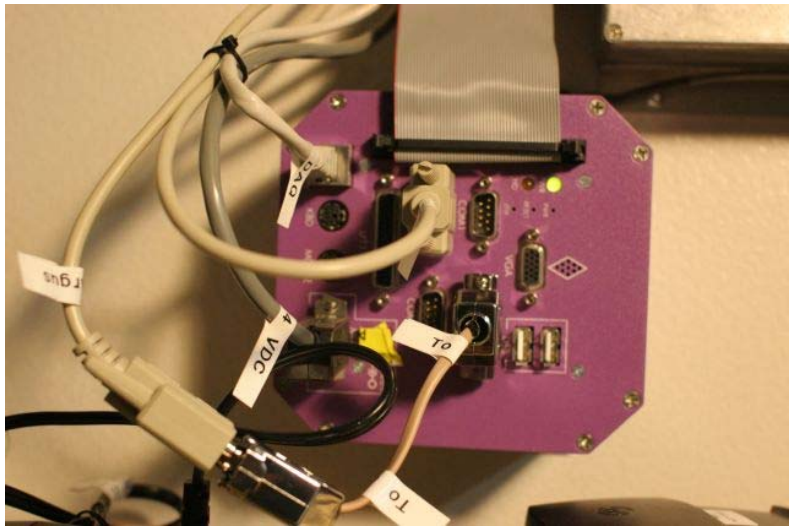
Base Station:

- **Polling schedule**
- **Data retrieval and distribution**
- **E-mail alerts**



Ivotuk, Alaska, Autonomous Instrumentation Platform

- **Health and status monitoring for:**
  - **Diesel, wind, and photovoltaic power systems**
  - **StarBand geostationary satellite communications system**
  - **Local processing computer (PC)**
- **Webcam image and command buffer**
- **PC/104 processor with data acquisition**



Advanced Modular Incoherent Scatter Radar (AMISR)

- **Next generation of Sondrestrom, Greenland, system**
  - **Original did a save and display of 6 receiver channels (1.2 MBytes/sec)**
  - **Selected data display over 384-kbps, 2-hop, VSAT link**
- **Gumstix processor**
  - **400-MHz ARM, 64-MB RAM, Digital I/O, Bluetooth, Linux**
- **Scaling of command and control to 1728 processors**

The Data Transport Network

- **Transport and Management routines overlay reliable Network News Transport Protocols**

- **Scaleable for:**
  - **Processor speed**
  - **Channel bandwidth**
  - **Input processes**

- **Open source, Linux-based code available at:**

http://transport.sri.com/TransportDevel

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7th Annual Clean Snowmobile Challenge

- Hosted by Michigan Technological University, Houghton, MI
- Initially driven by need for cleaner and quieter machines in the National Parks
- Weighted criteria
  - Reduced Emissions
  - Reduced Noise
  - Endurance
  - Towing Capability
  - Oral & Written Presentation
- Oxygenated Fuel
  - E20 (20% Ethanol) max for polar use

The start of the 100 mile endurance run to Copper Harbor – not all finished!

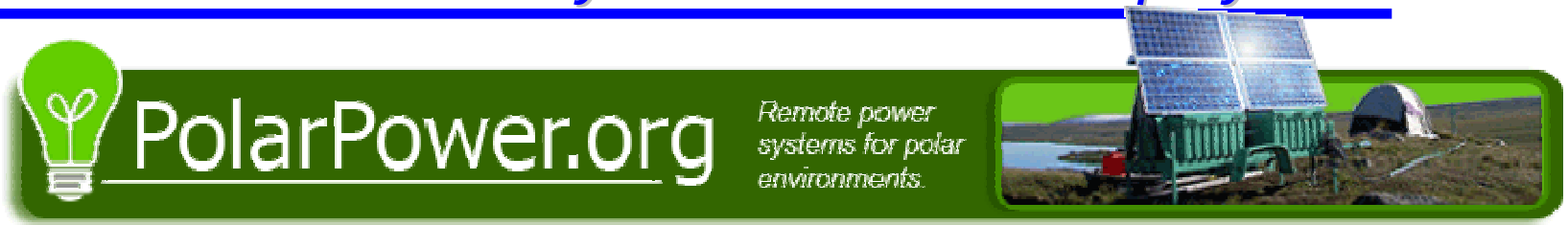
7th Annual Clean Snowmobile Challenge – cont'd

- **Zero Emissions Category added in 2006 at VPR's urging**
- **Obvious need for use at research sites in the Arctic & Antarctic**
- **2nd year for McGill University (Canada) entry**
  - **100-lb machine**
  - **Li-Ion battery ($5K)**
  - **CVT transmission**
  - **20-MPH top speed**
  - **1200-lb sled pull**
  - **7.5-mile range before failure (12-15 mile potential)**

7th Annual Clean Snowmobile Challenge – cont'd

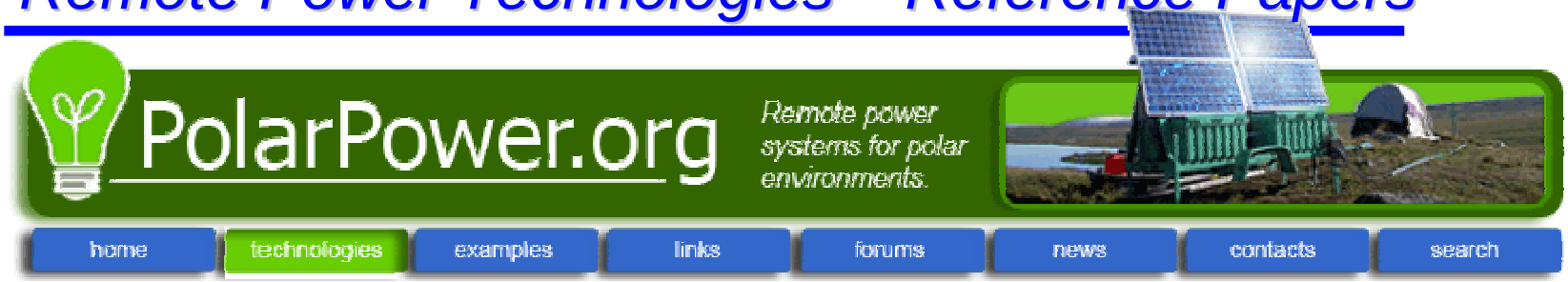
- 1st year for Utah State University entry
- Overall winner in class of 2 (Mid-pack of all Challenge entries)
  - 950-lb machine
  - Lead-acid battery
  - Weight penalized top speed
  - 1200-lb sled pull
  - 9-mile range

Website on Power Systems for Polar Deployment

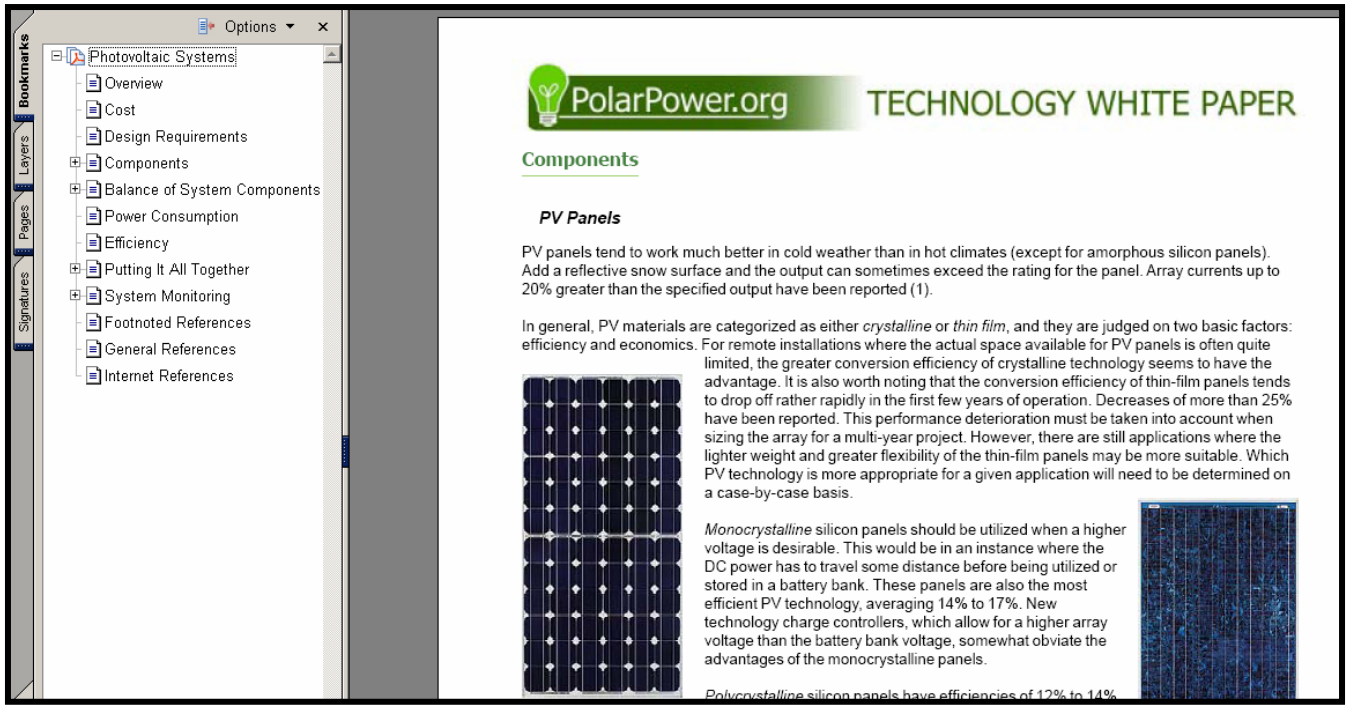


POLAR RESOURCES

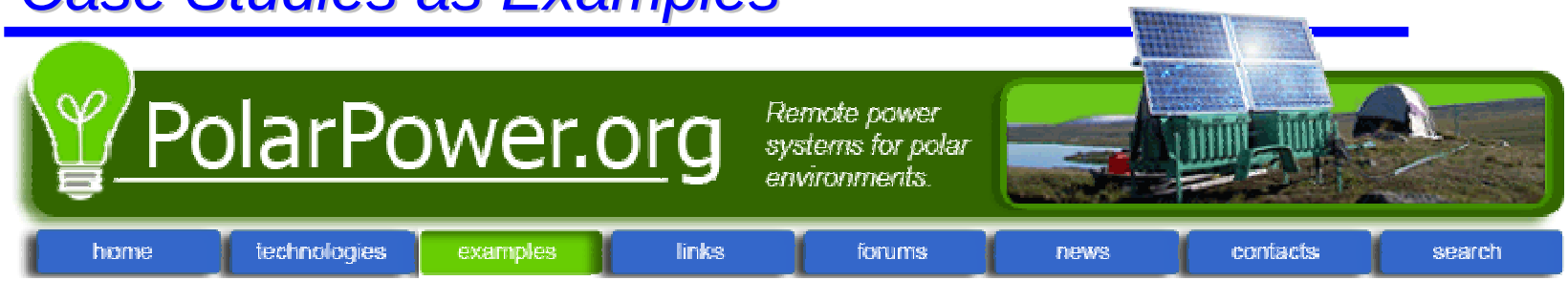
Remote Power Technologies – Reference Papers



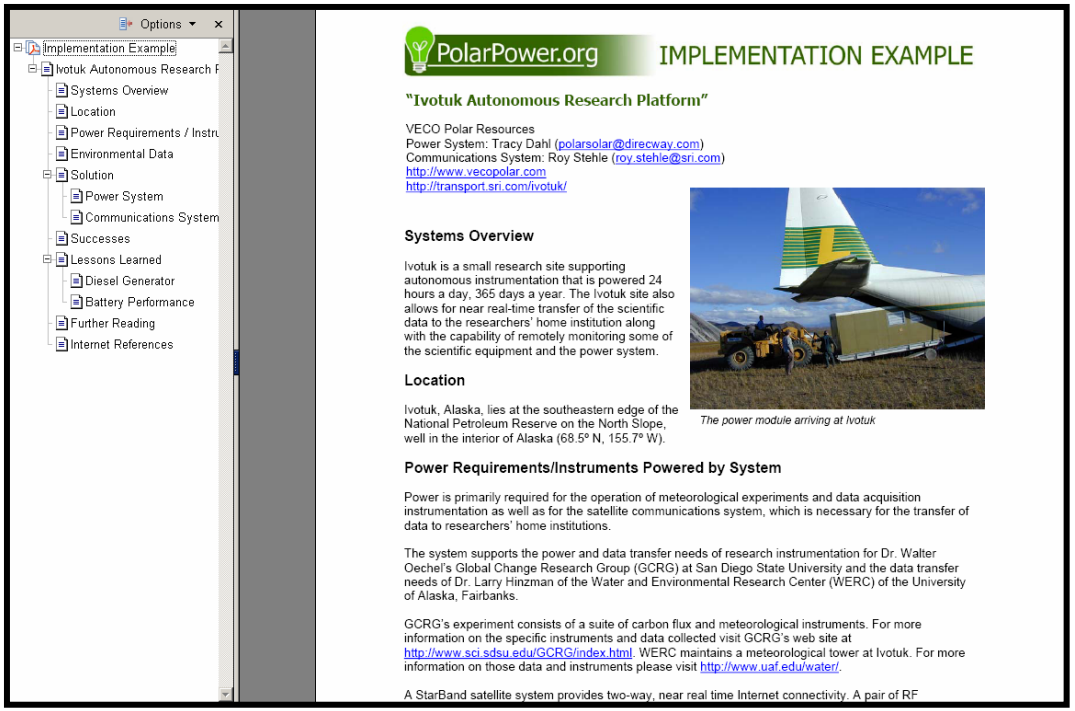
- **Series of PDFs offering detailed discussions of available technologies, determining suitability, design and implementation considerations**
  - **Topics such as...**
    - ✓ **Solar**
    - ✓ **Wind**
    - ✓ **Engine Generator**
    - ✓ **Electrical Fundamentals**



Case Studies as Examples



- **Existing deployments as examples of the technology used**
- **Seeking additional write-ups**
  - **Systems**
  - **Components**
    - » Power Drain
    - » Temperature Range
  - **Timers**
  - **Communications**
  - **Lessons learned**
  - **Other?**



POLAR RESOURCES

NSF's Arctic Logistics Support through VPR

Who Qualifies?

- **Primarily Arctic Program, but support given to other OPP, non-Polar directorates within NSF, and even non-NSF agencies**
- **2004 support (over 100 projects)**
  - **NSF/OPP - 63%**
  - **Other NSF – 18%**
  - **Other US gov't (mostly NASA) – 8%**
  - **Foreign Funding Agencies – 9%**

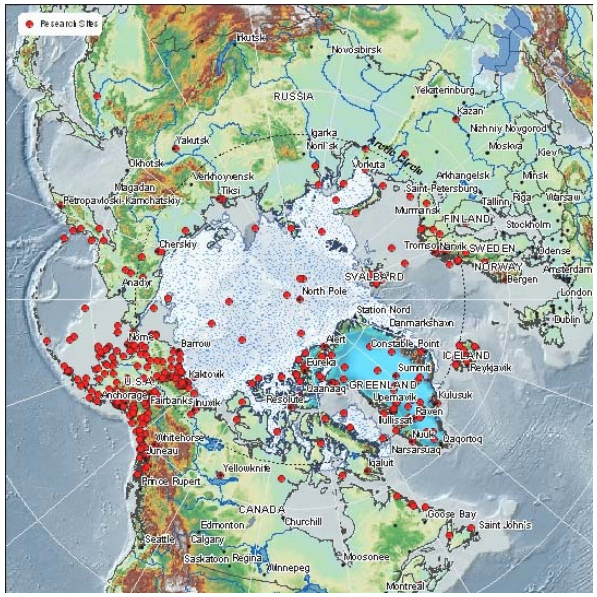
NSF's Arctic Logistics Contractor:
VECO Polar Resources

- **Collaborative effort**
  - **VECO, USA – Contract lead & management, construction, engineering**
  - **Polar Field Services – Project planning, field management and logistics**
  - **SRI International – Communications, computers, and power**
- **Funded through NSF's Arctic Research Support and Logistics Services Program**

Services Available

Areas of Support

- **Field Camps & Gear**
- **Air & Ground Transport**
- **Cargo Movement**
- **Safety & Remote Medical**
- **Polar Technologies**
  - ⇨ **Construction & Engineering**
  - ⇨ **Communications**
  - ⇨ **Power Systems**



Locations

- **Alaska**
- **Greenland**
- **Canada**
- **Russia**
- **Arctic Ocean**
- **Northern Europe**

How to get support?

- **Contact VPR (http://www.vecopolar.com)**
- **Obtain support letter/logistics estimate to include in your NSF proposal**
- **Non-NSF support determined with Simon Stephenson, NSF Arctic Research Support and Logistics Program Manager, on a case-by-case basis and may include interagency funds transfer or cost-reimbursable support**