

Polar Technology: Power & Communications Options

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Polar Technology Conference

Mountain View, California

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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



NSF Project © Ivotuk, AK Fri Sep 17 2004 18:30:07 AST; Cam temp: +22.5°C Exp: 683



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 μ F)**
 - **“Only happens at remote locations”**
- ❑ **Red blooming in bright sun**



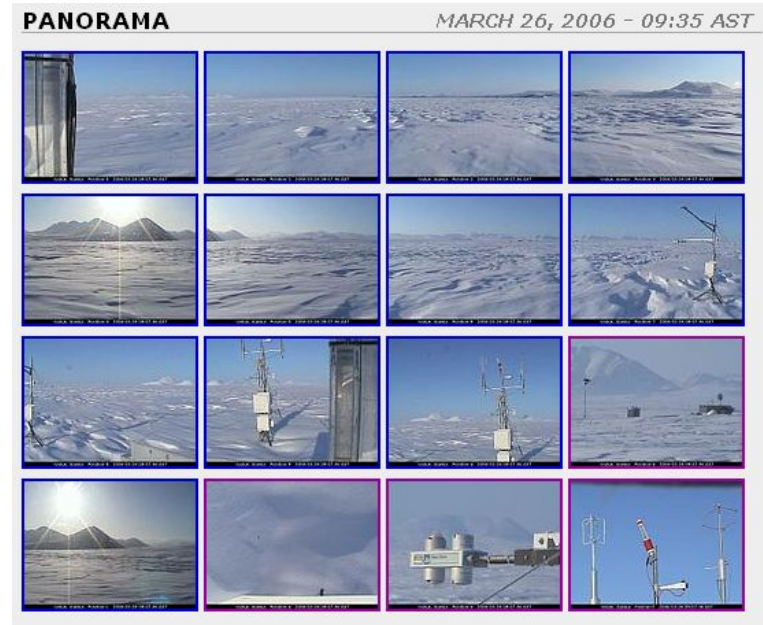
StarDot Technologies Netcam (Cont'd)

- ❑ **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



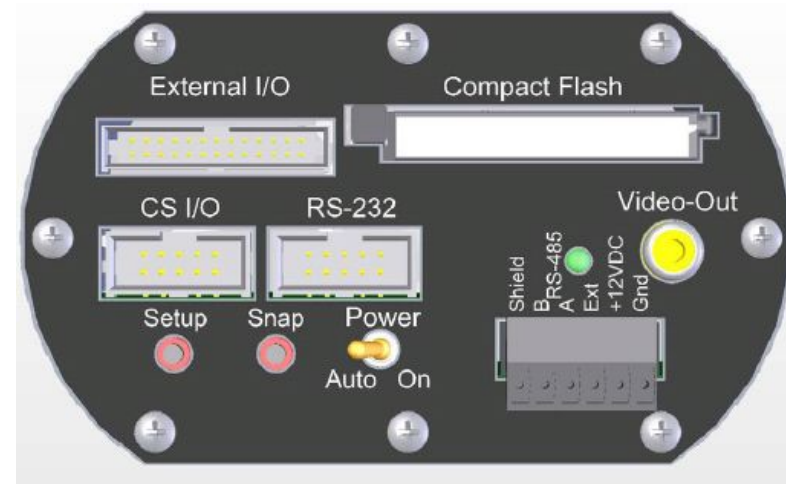
Rime Icing at Ivotuk, Alaska

- ❑ 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

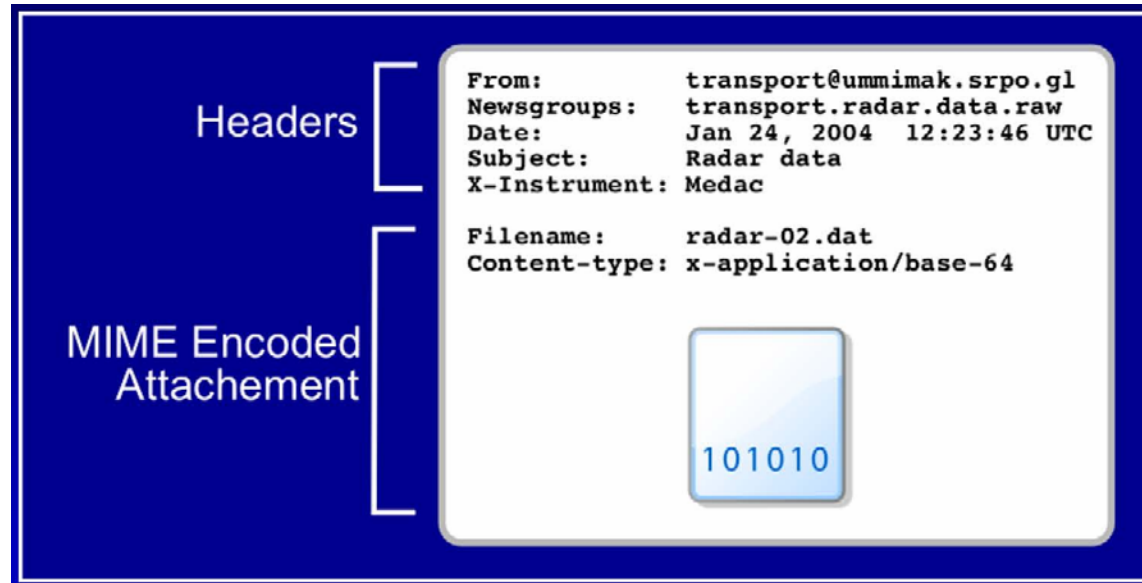


Campbell Scientific Inc. CC640 Digital Camera

- ❑ 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

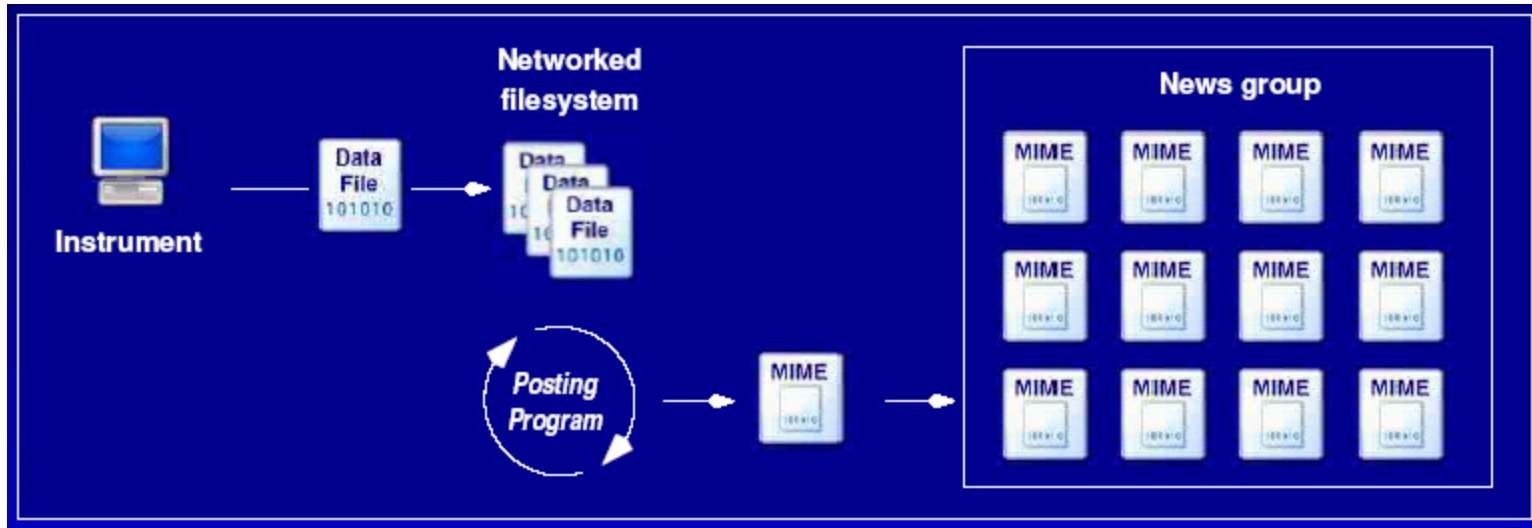


The Data Transport Network



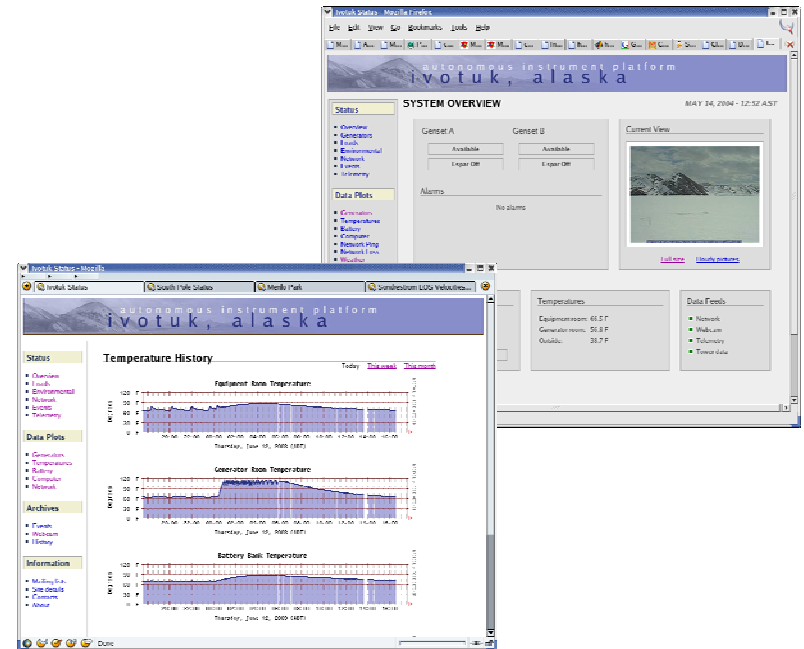
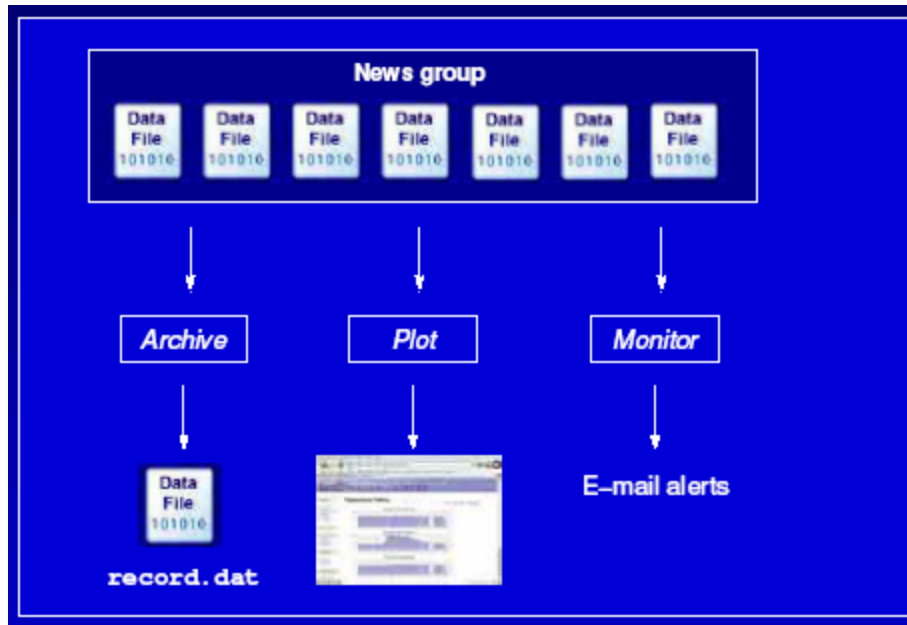
- ❑ Data transfers as Usenet message attachments
- ❑ Well developed protocols for reliable message transfer over a wide variety of networks
- ❑ Headers provide the metadata; content can be any type of data

Newsgroup Message Queue



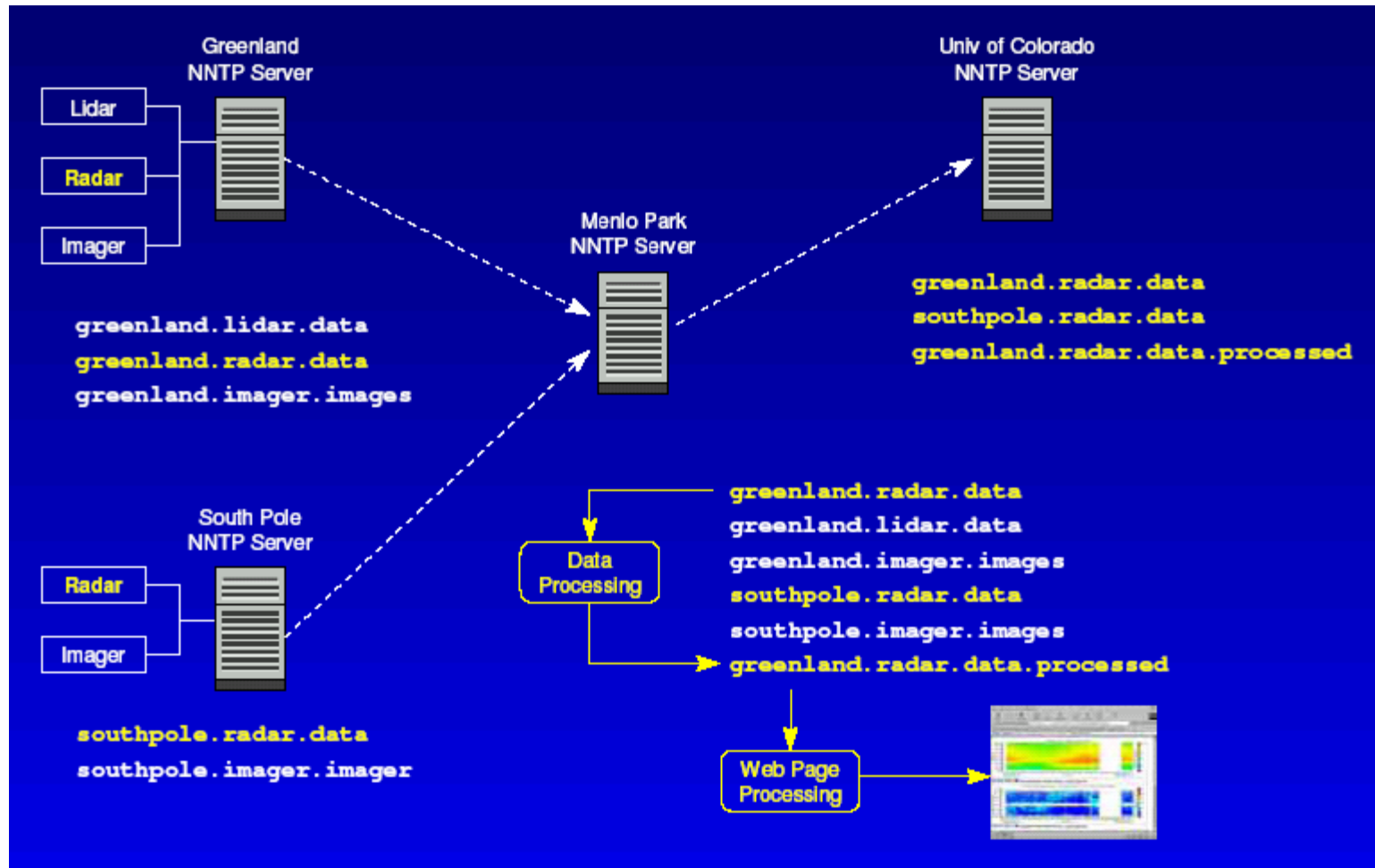
- ❑ Remote device writes data files to shared network folder
- ❑ Posting program encodes data into message format
- ❑ Newsgroup acts as a queue to hold messages
 - Multiple newsgroups can be handled

Newsgroup Publication and Subscription



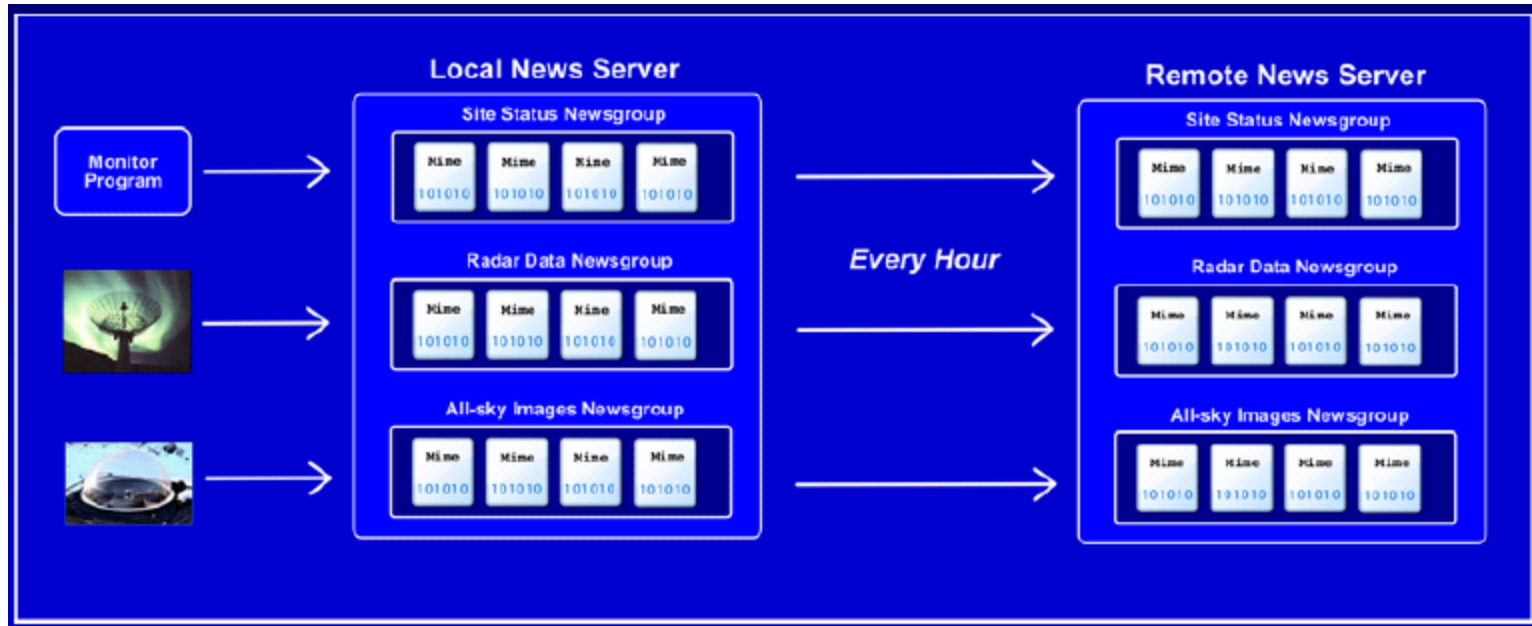
- ❑ One producer, many consumers (i.e., marketplace)
- ❑ Short-term history with automatic expiration
- ❑ Data interpretation for quick-look display
- ❑ Status monitor with distribution of Alerts through e-mail distribution

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)

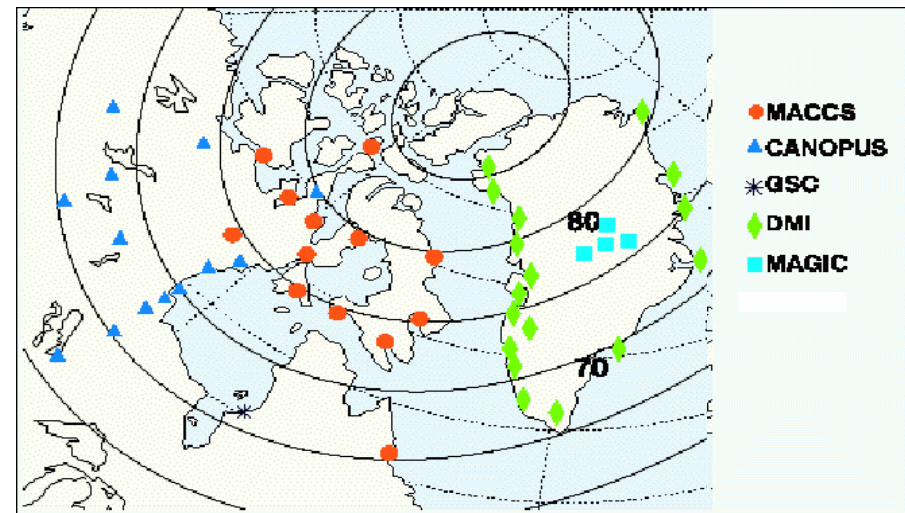
- **Distributed Iridium-communicating sensor network**
 - **2 Remote stations per Master polling station**
 - **10-minute polling interval**
 - **~30% of cycle available for abnormal condition handling**
 - **~3 Mbytes/station/day of data in compressed form**

Remote Stations:

- Data collection
- Archival to CD
- Health and status

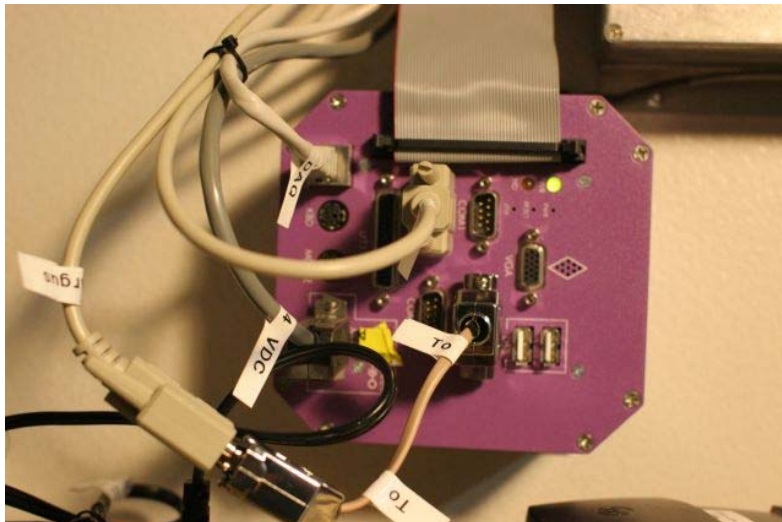
Base Station:

- 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



PolarPower.org

Remote power systems for polar environments.

[home](#)[technologies](#)[examples](#)[links](#)[forums](#)[news](#)[contacts](#)[search](#)[Site Map](#)[About Us](#)[Browsers](#)

> [Home](#) >

About the Site

PolarPower.org is funded by [National Science Foundation](#) with the goal of providing a useful working resource for researchers in choosing, designing, implementing, and maintaining remote power systems in polar environments. The site will allow the polar research community to establish a foundation of knowledge, share experiences, and stay current on technological developments.

The development of this site was a direct result of recommendations from the [1999 Autonomous Systems in Extreme Environments Workshop](#) and the [2004 Renewable Energy Working Group Meeting/Workshop](#)

Looking for *Polar Power, Inc.*? They're at <http://polarpowerinc.com>.



SRI International

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

The image is a screenshot of a web browser displaying a PDF document. The browser's address bar shows "Options" and "x". The left sidebar contains a "Bookmarks" panel with a tree view under "Photovoltaic Systems":

- Overview
- Cost
- Design Requirements
- Components
- Balance of System Components
- Power Consumption
- Efficiency
- Putting It All Together
- System Monitoring
- Footnoted References
- General References
- Internet References

The main content area shows the PDF's header with the PolarPower.org logo and the title "TECHNOLOGY WHITE PAPER". Below the header is the section "Components" with a sub-section "PV Panels". The text discusses PV panel performance in cold weather, mentioning that output can exceed ratings by up to 20% with reflective snow. It also compares crystalline and thin-film technologies, noting that crystalline panels have higher efficiency but thin-film panels are more suitable for remote installations due to their flexibility and weight. Two images of solar panels are included: a large monocrystalline panel on the left and a smaller polycrystalline panel on the right. The text concludes that monocrystalline panels are better for high-voltage applications, while polycrystalline panels have efficiencies of 12% to 14%.

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?



Implementation Example

- Ivotuk Autonomous Research Platform
 - Systems Overview
 - Location
 - Power Requirements / Instruments
 - Environmental Data
 - Solution
 - Power System
 - Communications System
 - Successes
 - Lessons Learned
 - Diesel Generator
 - Battery Performance
 - Further Reading
 - Internet References

IMPLEMENTATION EXAMPLE

"Ivotuk Autonomous Research Platform"

VECO Polar Resources
Power System: Tracy Dahl (polarsolar@direcway.com)
Communications System: Roy Stehlie (roy.stehlie@srn.com)
<http://www.vecopolar.com>
<http://transport.srn.com/ivotuk/>

Systems Overview

Ivotuk is a small research site supporting autonomous instrumentation that is powered 24 hours a day, 365 days a year. The Ivotuk site also allows for near real-time transfer of the scientific data to the researchers' home institution along with the capability of remotely monitoring some of the scientific equipment and the power system.

Location

Ivotuk, Alaska, lies at the southeastern edge of the National Petroleum Reserve on the North Slope, well in the interior of Alaska (68.5° N, 155.7° W).

Power Requirements/Instruments Powered by System

Power is primarily required for the operation of meteorological experiments and data acquisition instrumentation as well as for the satellite communications system, which is necessary for the transfer of data to researchers' home institutions.

The system supports the power and data transfer needs of research instrumentation for Dr. Walter Oechel's Global Change Research Group (GCRG) at San Diego State University and the data transfer needs of Dr. Larry Hinzman of the Water and Environmental Research Center (WERC) of the University of Alaska, Fairbanks.

GCRG's experiment consists of a suite of carbon flux and meteorological instruments. For more information on the specific instruments and data collected visit GCRG's web site at <http://www.sci.sdsu.edu/GCRG/index.html>. WERC maintains a meteorological tower at Ivotuk. For more information on those data and instruments please visit <http://www.uaf.edu/water/>.

A StarBand satellite system provides two-way, near real time Internet connectivity. A pair of RF

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%



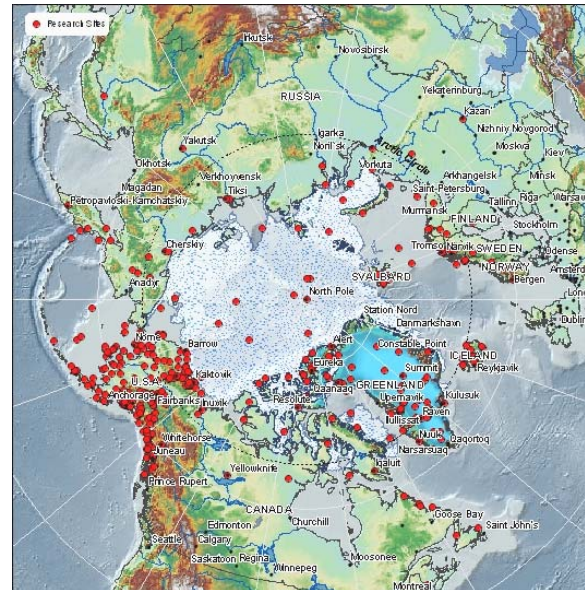
NSF's Arctic Logistics Contractor: **VECO Polar Resources**



- 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

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**