OPP-CISE Convergent Interests

• CISE
  – Provide new challenges/opportunities for networking community
  – Link networking research to practical solutions via engagement with science domains
  – Explore alternative networking test-bed locations, esp. those without FCC RF spectrum constraints

• OPP
  – Develop networking infrastructure in underserved polar regions
  – Transfer of networking technology and techniques to polar research domain sciences
  – Stimulate innovation and new approaches to polar research to increase vitality of research
Workshop Statistics

• Location: NSCA AccessGrid DC
• Joint NSF OPP & CISE/ANIR lead
  – OPP PI: Dr. Robert Loewenstein, Yerkes Observatory
  – CISE Co-I: Dr. George Markowsky, Head, Computer Science Dept, Univ. of Maine
• Balanced Community Representation
  – 4 Arctic attendees – 3 presentations
  – 6 Antarctic attendees – 5 presentations
  – 6 CISE attendees – 5 presentations
  – ~10 NSF staff drop-ins
• Workshop Web Site
  – http://www.polar.umcs.maine.edu
Workshop Goals

• Provide a venue for the two diverse communities to gain greater awareness of each other and share ideas

• Identify specific problems & needs in polar science as candidates for innovative and experimental communications and networking technology solutions

• Summarize the current and projected states of wireless, sensor, and power technologies for various field locations

• Establish teams of interested researchers for solving specific problems, leading to the development of new cross-disciplinary proposals

• Specify follow-on initiatives to the workshop
One User’s Needs Analysis

**VOICE**

- Compatibility
  - Seamless
  - Interoperable with different user platforms (field, camp, main station)
- Design
  - Small and portable
  - Reliable
  - Universal access
  - Interconnected with the global PSTN

**NETWORKING**

- Seamless compatibility with different platforms: data, video and audio
  - Mobile field personnel (data only)
  - Field camp
  - Animal-borne instruments
  - Autonomous stations
- Design
  - Broad band (e.g., capable of real-time 30 fps video)
  - Low power
  - Portable
  - Reliable
- Coverage
  - Total accessibility in local area
  - Global access through satellite link at main station

50-100 mi regional coverage around McMurdo with global connections
Typical Applications Cited

- Intelligent sensors (arrays), networked with adaptable operating configurations
- Low data rate burst telemetry – environmental sensors
- Store/forward data transfers
- Remote housekeeping
- Low refresh high-res Web cams
- On-line broadband Internet for ftp, ssh, http, etc.
- Streaming real-time digital video
- Educational outreach
The Problem

- Polar research conducted in continental sized regions at or beyond the reach of conventional global telecommunications infrastructure
  - Conventional communications satellites (geosynchronous) are solutions only to ~ 79° N/S
  - Terrestrial cables are rare (e.g., Alaska United and Svalbard cable)
  - Scattered population centers provide sparse islands of connectivity
- Extended field operations in remote regions requires scientist interactions with home institution for support, administrative purposes
- Trend for instrumentation is autonomous data collection with remote, on-line interaction
Geography of Networking By-passes the Polar Regions

Increasing Network Density

Increasing Population Density

Low Populations Correlate With Thin/No Networking Infrastructure

From: Modeling the Internet’s Large-Scale Topology
Soon-Hyung Yook, Hawoong Jeong, Albert-László Barabási
Department of Physics, University of Notre Dame, Notre Dame, IN 46556, USA, 2001
Example - Sparse Arctic Coverage

Islands of coverage provided by satellite (e.g., SES Americom AMC-8, etc.)

Aleyska Fiber
GCI
Alaska United Fiber

ACS
Wireless Cellular Coverage
Findings - Scope

- Demarcation point appears to be the individual researcher’s instrumentation
- Little discussion regarding computational/networking advances that could occur within the internals of instrumentation
- Focus applied to what happens once the instrument needs to interconnect with the outside world
Findings - Connectivity

• Global Grid connections dominate requirements
• Connectivity viewed as the technical challenge
• Scale varies from bps to Mbps
• Many field scientists presently have nothing
• Islands of connectivity exist in both polar regions (select population centers, stations, etc.)
• New mobile satellite systems (e.g., Iridium in particular, plus possibly others like Globalstar and INMARSAT) offer opportunities for connectivity in hard to reach high latitudes
Findings - Coverage

• Fixed point solutions are easier to solve
• Roaming regional wireless networking (voice & data) covering research areas of interest has greater unmet need
• Islands of connectivity are not well exploited for extending the reach of the network fringe
Findings - Technology

• Many/most research requirements are solved using available off-the-shelf networking products
• IEEE 802.11xx standards clearly dominate thinking
• “Stretching” the state-of-the-market with modifications has apparent appeal v. R&D for totally new systems
• FCC power emission limits on commercial unlicensed band equipment sited as an impediment
• Power systems identified as a critical enabling technology - solutions suited for polar region applications
Findings – “Sociology”

• Some Polar researchers are more network savvy than others; those who are not are often at a loss for gaining expert assistance
• Self-help or other design/technique assistance needed in a sustaining sense (institutional?)
• Arctic needs are viewed as very similar to Antarctic
Findings - Ideas

• Space Internet initiative has a correlation with polar region networking needs for thin and episodic connections
• Out-of-box thinking could result in novel approaches to solving niche coverage needs (e.g., “ReindeerNet”)
• Endorsement given to OPP for its build-out plan for wireless networking in/around McMurdo Station (sea ice, Dry Valleys research sites)
Workshop Follow-on

- Finalize proceedings
- Thoughts on information dissemination
  - Develop website
  - Consider discussion group, listserv tools
  - Polar Mentor Network
  - Work toward Global Connectivity – “International Science and Technology Year”
  - Human networking with the Cyber Infrastructure community
  - Prepare posters and PowerPoint presentations that volunteers can take to meetings & conferences
  - Target professional organizations’ conferences (e.g., LTER, AGU, SEARCH)
- Keep the inter/intra community dialog going