6.10 ANTARCTIC INTERNET DATA DISTRIBUTION (ANTARCTIC-IDD) SYSTEM

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1. INTRODUCTION

A data distribution network has been established for Antarctic research and operations. The Antarctic Internet Data Distribution (Antarctic-IDD) system is based on the Local Data Manager (LDM) software developed by Unidata (Davis and Rew, 1994; Yoksas et al. 2006) and compatible with the overall Unidata IDD/LDM architecture. This pioneering network is designed to alleviate some of the challenges of acquiring and distributing data in Antarctic meteorological community.

Internet connectivity to and from the Antarctic continent is costly and generally of low bandwidth. The distributed nature of meteorological research and observational efforts in the Antarctic (i.e., many small projects and local programs) results in a variety of small but valuable datasets. Distributing these data to other researchers, forecasters and logistic decision makers has been a continuous challenge. Solutions to some of these difficulties, such as better Internet communications, are some years away. In the meantime, sharing and distributing Antarctic data has often been done in an informal and ad hoc manner, often based on personal contacts. Operational forecasting for logistical activities in the Antarctic, and active Antarctic meteorological research programs are in need of a reliable, steady flow of meteorological observations, model output, and other related data in what is a highly collaborative environment (Knuth et al. 2003).

Over the last few years, discussions spear-headed by the National Science Foundation (NSF), the agency that oversees the United States Antarctic Program (USAP), have led to a community discussion on collaborative efforts. The June 2004 Antarctic Automatic Weather Station – Antarctic Meteorological Research Center – Antarctic Mesoscale Prediction System (AAWS-AMRC-AMPS) joint annual meetings included a discussion on the synergy of the Antarctic meteorological community. The initiative to come from this discussion brings to life a community effort, with the leveraging help of another NSF funded project, the Unidata program. The result is the establishment of the Antarctic-IDD system. The objective is to provide a

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system to reliably share and distribute Antarctic meteorological data.

Each participating site runs the Unidata LDM software, which is in almost continual communication with one or (preferably) more other sites. Data files properly identified and inserted at one site into a local database file (called a "product queue") are then available for almost immediate transfer to the product queues at other sites. The result is a collaborative network of sites, each sharing the datasets available to them. This system was setup in a test mode and demonstrated in the spring of 2005. Currently, the Antarctic-IDD is growing to include a variety of data sets from a variety of data providers for a variety of users. At this time, the Antarctic-IDD carries surface and upper air observations, satellite observations and products, as well as numerical model output.

2. THE INITIAL TEST

Plans for the initial test required that the primary participants be trained in the installation, administering, and maintenance of Unidata's LDM software. From fall of 2004 to mid-winter of 2005, several of the Antarctic-IDD participants took part in LDM training sessions, hosted by the Unidata program at UCAR in Boulder, CO. This initial education has proven to be vital in easily and quickly setting up the Antarctic-IDD. Plans during these training sessions, and over an e-mail discussion list, prompted the drafting of an initial plan for a topology of the Antarctic-IDD network (See Figure 1).

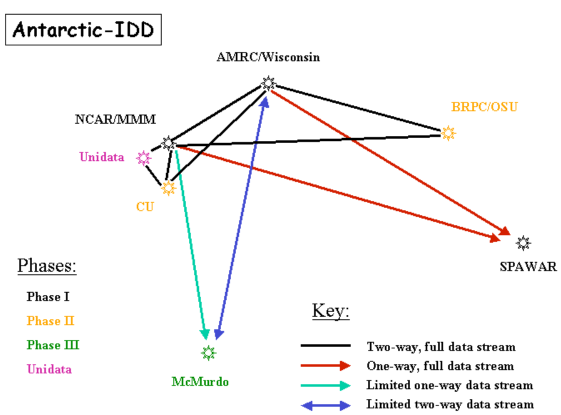

Figure 1 A graph of the original planned phase in of the Antarctic-IDD that depicts primarily nodes at AMRC/Wisconsin, SPAWAR, and MMM/NCAR with expansion to other sites including BRPC/OSU, CU, Unidata and McMurdo Station, Antarctica.

In late February of 2005, initial network connections were established, first between the AMRC and the Byrd Polar Research Center's Polar Meteorology Group at The Ohio State University. Quickly, other sites joined, including The Antarctic Program Office at SPAWAR System Center Charleston, the Antarctic Mesoscale Prediction System (AMPS) Group at the National Center for Atmospheric Research (NCAR), and University of Colorado. Table 1 includes a list of the current Antarctic-IDD participants.

Table 1. Antarctic-IDD Participants
AMRC, University of Wisconsin-Madison
University of Colorado - Boulder
SPAWAR System Center Charleston
MMM, National Center for Atmospheric Research
BPRC, The Ohio State University
National Scientific Balloon Facility
Alfred Wegener Institute (via AMRC/Wisconsin)
McMurdo Station, Antarctica [1]
(Joint AMRC/Wisconsin & MacWeather/SPAWAR)
[1] *Will be added during the 2005-2006 Antarctic Field Season*

3. CURRENT NETWORK AND EVOLVING TOPOLOGY

Immediately in setting up the initial connections between the USAP meteorology institutions and groups, some discoveries were made. First firewalls are presenting more of a problem than planned. It had been expected that the SPAWAR group would have significant firewall blocks that renders them unable to be a top tier relay for the Antarctic-IDD. This has proved to be true, however, due to the fortunate capabilities in the LDM software, they are still able to participate fully in receiving and providing products to the Antarctic-IDD. The surprise discovery was that firewall regulations at the Mesoscale and Microscale Meteorology Division at NCAR, that houses the AMPS group, has prevented that group from also being a top tier relay node for the Antarctic-IDD. The results of these developments place the AMRC as the only top-level relay node. This is sufficient to demonstrate the Antarctic-IDD, but provides a single point of failure for the network (See Figure 2).

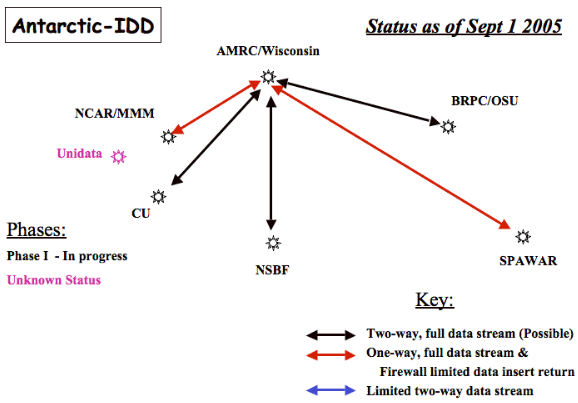

Figure 2 A graph of the September 1, 2005 status of the Antarctic-IDD, which clearly depicts the current single point of failure in the current demonstration topology.

The planned topology for the Antarctic-IDD boosts BPRC/OSU and CU to level relay sites. These sites will be able to continue to support the Antarctic-IDD if there are any failures at AMRC/Wisconsin. Plans that are in progress, as of this writing, include adding the McMurdo Weather and AMRC offices at McMurdo Station, Antarctica that will each run the LDM, sharing the responsibilities of providing and acquiring data for both operational and research use.

The future plan includes expansion to include the National Scientific Balloon Facility at its home base in Palestine, Texas (being added as of this writing) and at the telemetry building at Williams Field, Antarctica in support of their Long Duration Balloon launches (See Figure 3). It is hoped that other international Antarctic and US groups, in both Antarctic and home nation institutions, consider joining the Antarctic-IDD evolving topology.

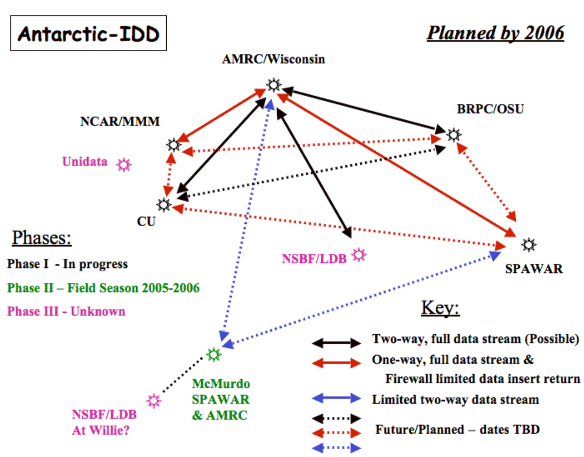

Figure 3 A graph showing the planned topology for the Antarctic-IDD for the year 2006. Note the improvement in reducing single point failure.

4. DATA: OFFERINGS, FORMATS, PRODUCT NAMING PROTOCOL

The first data available on the Antarctic-IDD were Antarctic composite satellite images from the AMRC, and observations from the SPAWAR AWS network close to McMurdo Station Antarctica. Since this initial offering a wide variety of data – both observational and prognostic – are now available on the Antarctic-IDD. The list outlined in Table 2 was the status as of the writing of this paper. The contents are increasing.

Table 2. **Antarctic-IDD Data**	**Data Source**
Antarctic Composites (Infrared, Water Vapor, Psuedo-Color Infrared and Experimental Visible)	AMRC/Wisconsin (Lazzara et al. 2003)
AWS observations	AMRC/Wisconsin (Keller et al. 2005) SPAWAR/McMurdo Weather
AMPS model output Analyses and Forecasts (all domains)	MMM/NCAR (Powers et al. 2003)
Neumayer Station Synoptic and Radiosonde Observations	AWI (Via AMRC/Wisconsin)
Antarctic Point Source Observations (METAR, Synoptic, Ship/Buoy, Radiosonde, PIREP/AIREP)	AMRC/Wisconsin

The data products placed on the Antarctic-IDD are given a specific pattern to be a unique class of products on the experimental or EXP data feed available as a part of the LDM software. Since the LDM software has fixed feeds built into it, the feed that made the most sense to use was the experimental or EXP feed. Although this feed is typically not used by others, since it could be, all of the products that are a part of the Antarctic-IDD have been prefixed with a USAP designator. Hence, products names typically take on the following form:

USAP.origin.product-descriptors.date.time.compression

Where,

* Origin is the source of the data product (e.g. AMRC)

* Product-descriptors are the items that describe the product (such as AWS for Automatic Weather Station Observations)

* Date and time are the date and time of the data

* Compression will be used in the future is a future used field that will be used to indicate the compress type for the data (e.g. gz for gzip compression).

As of this writing, data compression is not used. However, it will be implemented during the 2005-2006 field season to support data transmission to and from McMurdo Station, Antarctica. Internet bandwidth to and from McMurdo Station is currently very limited to only a small portion of a T1 (1.544 megabits per second) satellite connection.

Currently, data on the Antarctic-IDD utilize a variety of data formats. In fact, some datasets employ multiple formats before transmission. With the diversity of end users on the Antarctic-IDD (forecasters, researchers, educators, etc.), and a variety of interactive processing software used by end users (IDV, McIDAS, Terascan, Yosemite, etc.), it is neither possible nor practical to have all of the data use the same format type. Sharing of data via the IDD brings to the forefront core problems in the Antarctic community with common data formats (e.g. lack of capability for everyone to share a set of formats, etc.) The Antarctic-IDD community is currently taking on this challenge.

5. FUTURE PLANS AND CHALLENGES

The future for the Antarctic-IDD includes plans for expansion on two fronts. First, expanding the data and product offerings is an on-goring and continuous effort. Efforts over the past several months by Antarctic-IDD participants, has produced an exponential increase in the volume of data. Additional data offerings and new products will be made to the benefit of forecasters, researchers and educators alike. It is hoped that research versions of numerical models will have output be placed on the Antarctic-IDD in real-time. Additionally, research versions of satellite-derived products will be ideal for transmission and sharing over the Antarctic-IDD.

On a second front, it is expected that the network will expand in the number of sites receiving and perhaps posting on the Antarctic-IDD. Also, there is an open invitation for anyone, domestically and worldwide, who participates in Antarctic research and operations to join the Antarctic-IDD. Ideally, having the Antarctic-IDD be a primary means for sharing and providing and acquiring Antarctic meteorological data is a possible end goal for this effort. This networking possibility highlights a challenge that faces the Antarctic meteorological community. Each nation has its own communication means to and from the Antarctic stations back to the home nation. There is little to no intra-continental communication capabilities in Antarctica. Hence, a future Antarctic-IDD will need to encompass communications worldwide.

6. ACKNOWLEDGEMENTS

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