



Science Requirements for South Pole Station Computing and Communications

A Report to the South Pole Users' Committee

by

The South Pole Working Group on Computing and
Communications

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May

1995

The Amundsen-Scott South Pole Station is rapidly increasing its role as a major scientific facility. However, unlike many facilities that support a single scientific discipline, the station resources must accommodate a variety of disciplines from astrophysics to seismology. This report attempts to address specific growing scientific demands on the computing and communications infrastructure, discussing justifications and recommendations.

The three main topics of this report - Communications, Networks, and Computers - all integrate together to form a necessary tool for the science effort. We may have to draw boundaries to help determine how to spend valuable resources on them, but these boundaries increasingly blur and disappear as the dependence of scientific research upon long distance networking grows.

Since the previous report from this working group two years ago both improvements and losses in capability have occurred. Many of the recommendations from the previous report (see attachment) have neither been implemented nor discussed.

A summary scorecard for computing and communications is as follows:

Improvements in capability:

- Satellite bandwidth
(Bandwidth has improved, though availability remains about constant)
- Direct connection to the Internet
- Direct mail service (instead of a tedious hand transfer)
- Direct file transfer under user control

Losses in capability:

Important recommendations from this report:

- Implement prior recommendations

 - Semiannual(?) meetings for review and feedback between ASA and representatives of the Users' Committee

- For communications:

 - Improve availability and bandwidth
near term: 12 h/day and 1 GByte/day minimum

 - long term: 24 h/day and 2 GByte/day goal

 - Pursue TDRSS connection

 - Utilize prototype capabilities during winter

 - Improve uniformity of performance for operational systems

 - Improve documentation and sparing for operational and prototype systems - Improve domain name services

 - Add

 - remote phone calling (or patching)

 - multiplexed phone link on GOES-3

 - (limited) FAX capability

 - network prototyping support

- For local area network:

 - Add finger services (name@SPOLE.GOV)

 - Improve connection availability (and workspace) for portable computers

 - Support Appletalk network routed to ethernet LAN

 - Improve performance of network with subnetting and network segmentation

 - Use TCP/IP as primary access protocol

 - Remove IPX (Novell) to its own LAN

I. Communications

Almost all science experiments will benefit from more periods of Internet connectivity, increased bandwidth, and familiar software environments. Better communications will also benefit staffing, because experts will not necessarily have to be at the station to help maintain and configure the systems.

The wide area network access provides a vital suite of services for the science community including experiment monitoring, anomaly diagnosis, consulting, data transfer for concurrent analysis, time critical data entry into databases such as weather (WMO) and seismic monitoring (AFTAC), and remote experiment control. There are two access requirements, throughput and availability - the present desire for throughput is about 1 GByte/day, and the desire for availability is 24 hour coverage.

The cost-effectiveness of WAN access cannot be overemphasized. Prior to availability of the WAN, winter experiments at Amundsen-Scott station would commonly spend one season collecting data, a second season analyzing that data and designing fixes for anomalies in the data, and a third season testing the fixes. With WAN access, experimenters can examine the data in near real-time, diagnose anomalies and (often) implement fixes during the same season, providing a factor of two or more reduction in the cost of fielding successful experiments. Fast mail access, and the availability of teleconferencing, when required, facilitates correct diagnosis and repair of failures in complex equipment. The ability to interact directly with experiments from the US provides another dimension to improving the overall throughput of experiments. It makes it possible to vary the experimental paradigms on short time scales, to adapt the experiment to short-lived physical phenomena, and to include a much greater depth of scientific expertise than is possible with the small winter-over population. The participation of a wider community can also improve the acceptance and demand for the Antarctic program.

The ability to provide data to time-critical databases is also important for the stature of the Antarctic station. Data must be entered into the World Meteorological Organization system within about four hours to be included in predictive weather models. For seismic monitoring, the data must be on-line, with delays no greater than 30 minutes and having few accessibility gaps, to be relevant for AFTAC monitoring. The data from Amundsen-Scott station have important, unique characteristics for these databases, and would be in great demand if



Next winter season's data throughput is estimated to be ~1 GByte/day, assuming all planned projects become operational. This number is based on the sum of individual science program's estimates. This year, the existing data channels will become saturated. Table 1 summarizes the current situation as well as next year's projected capability.

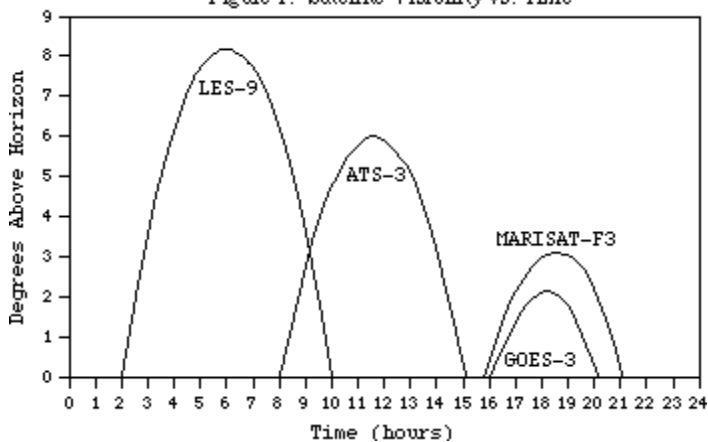
Table 1. Communication Summary

Satellite	1994			1995-96 (?) and beyond		
	bandwidth (Kbps)	~availability (hrs/day)	Throughput (MB/day)	bandwidth (Kbps)	~availability (hrs/day)	Throughput (MB/day)
ATS-3	voice	5	-	voice	5	-
LES-9	32 (128?)	6	69 (276?)	32 (128?)	5	69 (276)
GOES-3	-	-	-	256-512 (T1?) voice	3	276-552 (1500)
MARISAT-F3 (\$15-29K/month)	10 [56] voice	1 [5]	3.6 [100]	10 [56] voice	1 [5]	3.6 [100]
Effective Mbytes/day			72			348 - 624 (1876)

() - indicates possible maximum, depending on test results - when image my way.
[] - indicates maximum, depending on lease fees

Note that in order to fulfill this year's goals, it is extremely urgent that Marisat-F3 be brought on-line for the remaining of the winter season. While the gain in throughput is small, F-3's

Figure 1. Satellite Visibility vs. Time



possibility.

2. Better connection dependability

LES-9 can one day be very good, and another day be absolutely terrible. This is apparently caused by fading and ionospheric conditions. While it is unlikely that we can improve the performance, there are cases in which poor performance can be improved (bringing LES 9 from 24 Kbps up to 38.4 Kbps by changing modulation techniques is an example). A plan for ensuring satellite reliability should be developed and thoroughly reviewed.

In addition, the sparing and documentation for these critical satellite systems appear to be minimal at best. Time should be spent documenting what now exists.

3. Phone service to CONUS from the work areas

Currently, the ATS-3 phone link requires the winter-over to make the phone call from the Comms building. Not only is this inconvenient, but impractical. It is very important to make things as convenient and productive as possible. We recommend developing procedures to allow calls to be made at any phone on station. This should become the standard, continuing when GOES-3 and Marisat are available.



One issue is the changing role of communications in scientific activities. In the past, communications was perceived as strictly an information pathway. That perception is no longer valid, as communications now provide the means of controlling and modifying remote experiments, as well as receiving real-time data from them. While an "Information Systems" approach to communications operation has served well in the past, it is now worthwhile to review what role Science Support should play in this arena. For instance, should Science Support money go toward subsidizing some of the communications, given that communications is such an integral part of the science?

7. Prototype development strategy

Planning and budgeting for future communication possibilities is difficult to do, given how quickly some opportunities present themselves. We recommend that a more flexible procedure be developed that allows quick action to take advantage of targets of opportunity for better communications.

8. Risks should be accepted for prototypes

It is very probable that the evolution of better communications to the Pole will continue in rapid bursts of testing, prototyping and phased implementation. Once proven, a prototype can be cleaned up for acceptance as standard equipment for station; if the prototype fails, it still may serve as a testbed for later success.



MaterialsO&M
||
(Novell server any branch)
||
domain serverOPS_router
(sun or alpha)|
||
_____ backbone (sci or comms or both)
||
Science router|
||
_____ Comms_router
|||||
|||||(satellites)
Skylab Clean_air MOPF |Science bldg|
IRISrouter | (+appletalk to TCP/IP)(voice MUX)
|| (general printer)
||
||__CARA astronomy net
general
(Appletalk to TCP/IP)
(general printer)

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Requests by groups for a subnet address allocation which they configure and maintain, and/or a physical subnet, separated by a router, should be honored. Conditions of agreement should include a requirement of registering all domain addresses with the system manager (for the name server, network diagnosis, and packet accounting), and keeping the network wiring configuration diagram current. This would greatly reduce the number of discussions and negotiations over network configurations, would allow large continuing research projects to configure their workstations in the manner most suitable for their research, and would off-load some of the responsibilities of the system manager.

3. Accounts

Install a finger server that is kept current.

Use the domain name for all accounts, so that `rfl@spole.gov` is sufficient to email to rfl. Likewise, fingering a name `@spole.gov` should return adequate information to facilitate contacting that person. At present, individual machine names have to be known to reach a person at Pole, and it is not always possible to determine how to email to them without fingering first. Example: how do you contact Dave Fischer at the pole by email (assuming he were still there at this moment).

There may be a problem of keeping the database current with the transient population at pole. Also local managers have to inform the system manager of changes. But even with these few inaccuracies, the system could be better than it is now.

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convenient for portable computers. The route tables, addressing paradigms, and naming conventions are not sufficiently dynamic to deal conveniently with computers that change physical location frequently. Among the better alternatives is to telnet to the investigators' home computer and providing mail addresses on a station computer at south pole station. It is often difficult to remotely access mail on personal computer-based mail systems.

Recommendations:

1. Familiar computing environments and support

In the last paper generated by this working group, we listed as a guideline for upgrading the computing environment that there should be support for the four major computer platforms: SUN (UNIX), VAX (VMS), Macintosh, and PC. Some progress has been made and the situation is certainly better than it was several years ago. But there are still deficiencies. The predominant additions to the science building have been PCs, which



One of the basic needs of the short term researcher is the availability of work space. The space in the science building is overtaxed with emailers and non-research activity, with no desk space for the itinerant researcher. Is it possible to create more space in the science area? There is a storage room behind the SPASE area that could be cleaned out and used. There is no technical need to have all the terminals and computers in a single area. Perhaps some terminals can be placed in other areas of the Station.

We note that ASA has increased its own requirement for general workspace in the computer room with the use of MAPCON, CTS, and PTS inventory programs. This has had an impact on the science use of the space as well as the availability of terminals.

6. Common Networked Backup Device

Networked mass storage devices could benefit many projects and should be supported with necessary spares. Convenient backup methods should be available for all supported systems under user control.



A mixed computing environment is the norm for research groups, and system manager support is rarely given unless there are critical real-time requirements. It is not recommended that support staffing at South Pole be increased significantly to support the specified systems. Instead, new paradigms for support should be considered.

Recognizing that a single systems expert might be useful in McMurdo and even at ASA, South Pole might not have the expert on site for the entire summer season. With better communications to the station, experts do not necessarily have to be at the Station in order to help. Using remote logins, staff at McMurdo or CONUS may remotely assist with software support or other problems. We recommend the following division of labor between a systems Expert and a systems Manager to improve support at little added cost (in all cases below we refer to 'systems' as meaning ASA provided systems - researcher provided systems are the responsibility of that research group):

1. System Expert Duties

Experts should tune the computers, network devices, and communications gear near station opening and near station closing each year. It is believed that less than a week on site should be required for knowledgeable personnel to service these systems. The use of system experts will help ensure uniform performance. It is demonstrably true that, in the

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network addresses.

The system manager should be provided with simple and complete procedures for carrying out the above tasks. The backup/verify procedures should be automated to the extent possible. Each machine should have a standard reference system (provided by the expert) available on backup media so that the system manager can restore the functionality to a different machine should hardware failure, or a virus so require. To the greatest extent possible, the "transient" configuration information (such as user account information) should be kept separate from system software.

The system manager should be trained in restoring the system files for Macs and PCs, since those are files are most likely to suffer inadvertent modification by users. Users should be discouraged from modifying those files or adding software to the machines unilaterally.

The system manager should be trained in network configuration and network analysis, since an operable network is critical to correct functioning of the station.



improvements	?	1	1	1	
Workspace	15k	1	1	1	
Domain server	40K	1	1	1	Existing Sun, perhaps?
Segmenting subnet	0	2	1	1	3 Cisco, 2 Shiva
Novell off-load	30K	1	1	1	Requires
	30K	2	1	1	segmenting net
Computer replacement	30K	2	1	1	
4 MACs	15K	3	2	1	PPC
2 ALPHA					? if necessary for
2 SUN					Science One Sun
2 PC					exists (Aspen)?
					Pentium

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We strongly recommend periodic meetings among participants of the Science Users' Committee Working Groups and ASA personnel to discuss the actual implementation of requirements. In the past, recommendations from the users have, in many cases, gone unheeded or implemented in a manner not conducive for scientific research. Feedback from the science users in the planning process will help to ensure the best possible solution.

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