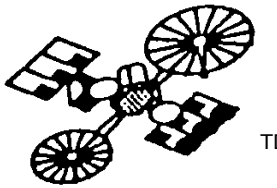
MISSION OPERATIONS & DATA SYSTEMS DIRECTORATE

August 21, 1997

South Pole TDRSS Relay (SPTR)



TDRS-F1
49^0W

Project Status Review

Code 531

Agenda

- Project Overview — Kevin Culin
  - Purpose and Scope
  - Objectives and Goals
  - Future Goals
- Operations Concept — Richard Schonbachler
  - Scheduling
  - Operations
  - Maintenance
- System Design — Dave Israel
  - System Diagram
  - Requirements
  - Hardware
  - MCS Software
  - Server Software
- Issues/Challenges and Mitigation — Dave Israel
- Schedule — Kevin Culin
  - Design and Development
  - South Pole Installation
- Hardware Status — Kevin Culin
- Budget — Kevin Culin
- Summary — Kevin Culin

PROJECT OVERVIEW

Purpose and Scope

- Purpose

  The purpose of the proof-of-concept South Pole TDRSS Relay (SPTR) system is to transfer scientific and station operations data from the Amundsen-Scott South Pole Station in Antarctica through the White Sands Complex (WSC) in New Mexico to Internet based customers.

- Scope

  The system to be installed in the 1997/1998 austral summer season is designed to meet the requirements for a year long proof-of-concept test combined with flexibility to adapt to rapidly changing requirements.

Objectives & Goals

- Install a proof-of-concept TDRSS Relay System at the South Pole Station
  - Ku-Band SA Return Link
    - » 50 Mbps data link capability with PN data
    - » 2 to 10 Mbps data link capability with science data
  - S-Band SA Forward and Return Link
    - » 1.024 Mbps full duplex data link capability
  - Leave equipment for year long proof-of-concept testing
  - Gather engineering data on link performance and statistics
- Demonstrate TDRSS service from a remote isolated location.
- Demonstrate TDRSS support for industry standard protocols (TCP/IP) and services such as Internet connectivity.
- Demonstrate data transfer capabilities to include:
  - SSA 1.024 Mbps full duplex service for scientific and station operations data.
  - KSAR 2 to 10 Mbps service for transferring bulk science data.
- Provide an R&D site to demonstrate high rate data (50 Mbps) transfer capabilities.

Future Goals

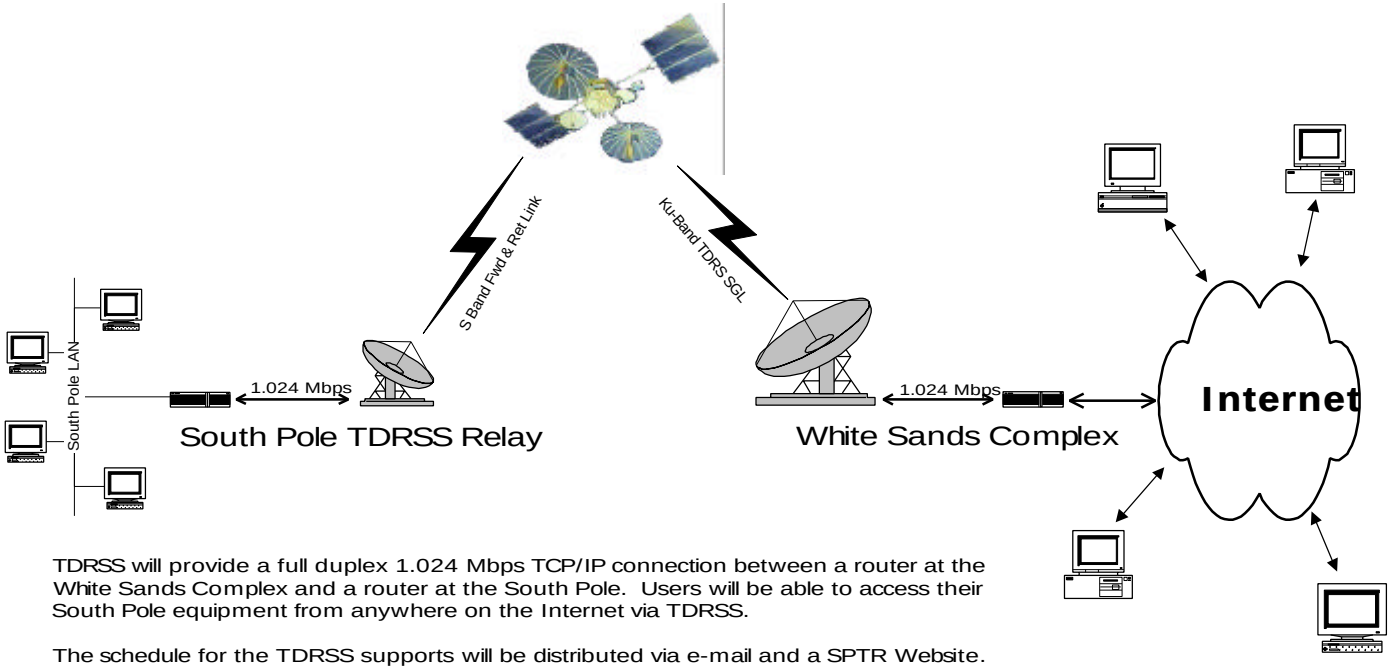
- Install Redundancy
  - The TDRS-F1 Relay has limited redundancy and sparing on the KSA service.
  - The TDRS-F1 Relay has no redundancy or sparing on the SSA service.
  - WSC has no redundancy for the two stations but does have some spares.
- Evaluation of antenna design
  - RFI interference with scientific experiments (Dark Sector)
  - Conventional antenna versus offset feed antenna
- Provide a faster Data Servers to increase bulk data dump rate
- Longer connectivity times

Customers

- Antarctic Muon and Neutrino Detector Array (AMANDA)
- Balloon Launch Facility
- Center for Astrophysical Research in Antarctica (CARA)
  - Antarctic Submillimeter Telescope and Remote Observatory (AST/RO)
  - Advanced Telescopes Project (ATP)
  - Cosmic Background Radiation Anisotrophy (COBRA)
  - South Pole Infrared Array Camera (SPIRAC)
  - South Pole Infrared Explorer (SPIREX)
- Joint Australian Centre for Astrophysical Research in Antarctica (JACARA)
  - Automated Astronomical Site-Testing Observatory (AASTO)
- NOAA
  - Climate Monitoring and Diagnostics Laboratory (CDML)
- NSF/ASA Support
  - Station Operations, Maintenance, and Logistics
- Smithsonian Astrophysical Observatory

OPERATIONS CONCEPT

TCP/IP Connection Operations Concept



TDRSS will provide a full duplex 1.024 Mbps TCP/IP connection between a router at the White Sands Complex and a router at the South Pole. Users will be able to access their South Pole equipment from anywhere on the Internet via TDRSS.

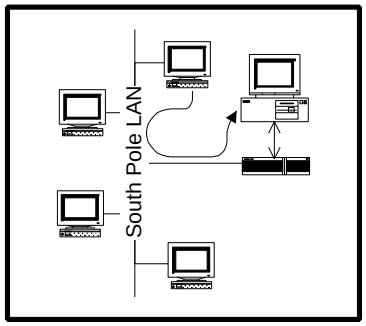
The schedule for the TDRSS supports will be distributed via e-mail and a SPTR Website.

The TDRS-1 satellite view periods will fill part of the gap between the current GOES-3 and LES-9 supports.

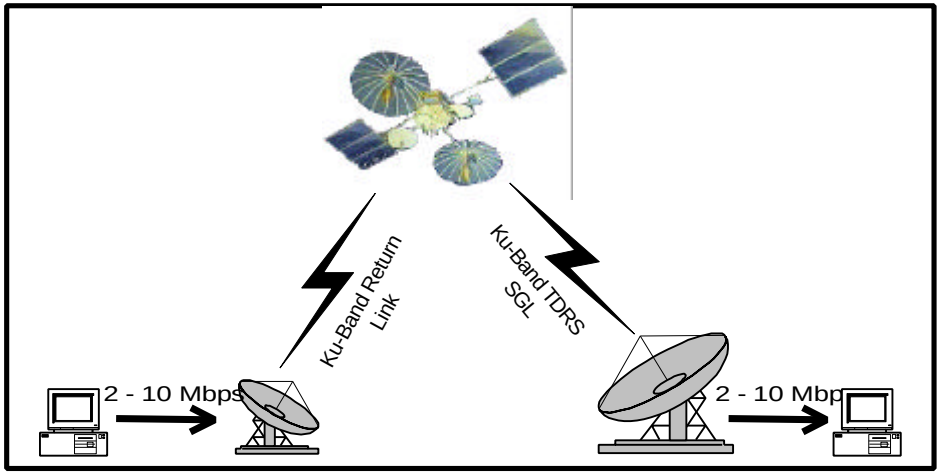
Predicted TDRS-1 coverage of the South Pole

Date	Inclination	Max El. Angle	Time > 0 deg
6/97	9.5	0.84	2hr 48min
6/98	10.1	1.43	4hr 5min
6/99	10.7	2.03	4hr 40min
6/00	11.3	2.64	5hr 15min

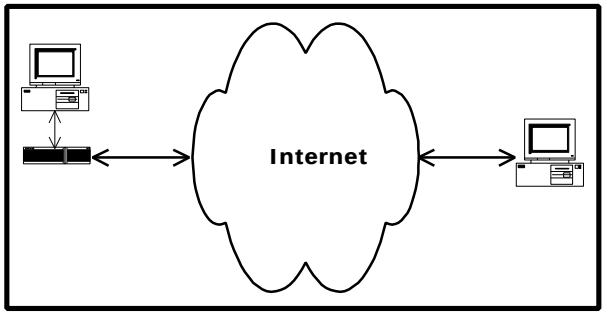
High Data Rate File Transfer Operations Concept



Step 1:
South Pole User copies file into the "mailbox" directory of the South Pole File Server (SPFS).



Step 2:
The SPTR system duplicates the contents of the SPFS "mailbox" directory onto the White Sands File Server (WSFS) during the daily TDRSS event.



Step 3:
South Pole User retrieves file off of WSFS via FTP (available 24 hours/day).

Notes:
1. Initial File Server Capacity will be approximately 2 Gbytes.
2. Files will initially be transmitted through TDRSS at 2-10 Mbps. (RF link designed for eventual 50 Mbps capacity)
3. Users will be responsible for placing their files onto the SPFS and removing them from the WSFS.

Scheduling

- SPTR WILL OPERATE VIA A MONTHLY SCHEDULE
  - GENERATED BY NCC
  - BASED ON VIEW PERIODS PROVIDED BY FDF
  - TRANSMITTED BY NCC VIA SPTR OPS EMAIL COLLECTIVE
- SPTR SCHEDULING PRIORITY IS BELOW ON-ORBIT OPS SUPPORT
  - NCC SCHEDULING WILL MAKE EVERY EFFORT TO PROVIDE DAILY CONTIGUOUS SPTR SUPPORT TIMES
- CHANGES TO MONTHLY SCHEDULE WILL BE TRANSMITTED TO ALL CUSTOMERS VIA SPTR OPS EMAIL COLLECTIVE
- NCC TRANSMITS DAILY SHO FOR WSC EXECUTION AND SUPPORT

SPTR Operations

- WSC WILL MONITOR SPTR LINKS AND GENERATE ANY GCMRs AS REQUIRED TO MAINTAIN COMMUNICATIONS
- SPTR LINKS WILL CO-EXIST WITH ESTABLISHED MALABAR, FL./SOUTH POLE OPERATION
  - ROUTER SCHEME DEVELOPED TO USE NSI FOR ALL IP TRAFFIC
- REAL-TIME VOICE COMMUNICATION W/CUSTOMERS OR SOUTH POLE OPERATIONS WILL NOT BE UTILIZED
- MAJORDOMO TYPE LISTSERVER WILL BE UTILIZED M&O AND CUSTOMER COMMUNICATIONS

SPTR Maintenance

- SOUTH POLE
  - ASA WILL PERFORM MAINTENANCE UNDER DIRECTION OF GSFC SPTR ENGINEERING
  - LRU LEVEL WITH AVAILABLE SPARES
  - PERIODIC ANTENNA ALIGNMENT
- WSC
  - SPTR-UNIQUE LI EQUIPMENT DUPLICATED AT BOTH GROUND TERMINALS
  - WSC TO PERFORM LRU LEVEL MAINTENANCE WITH AVAILABLE SPARES
    - » RETURN TO GSFC FOR REPAIR
  - ROUTERS AND DATA CIRCUITS MAINTAINED AND OPERATED BY NISN/MSFC

Problem Reporting and Resolution

- PROBLEM REPORTING BY CUSTOMERS VIA SPTR OPS EMAIL COLLECTIVE
- NCC/WSC WILL TTR/DR TDRSS EQUIPMENT PROBLEMS PER ESTABLISHED PROCEDURES
- SPTR EQUIPMENT PROBLEMS WILL BE REFERRED TO GSFC/SPTR ENGINEERING
  - SOUTH POLE PROBLEMS WILL BE COORDINATED WITH ASA PERSONNEL
  - WSC PROBLEMS WILL BE JOINTLY WORKED BY GSFC/SPTR ENGINEERING AND WSC TO&A PERSONNEL
- SERVICE ACCOUNTABILITY
  - MONITORED AND REPORTED (MINUTES OF SERVICE)
  - NO DATA LOSSES ASSESSED UNDER “PROOF OF CONCEPT”
  - CUSTOMERS ASSUME FULL RESPONSIBILITY FOR FILE MANAGEMENT ON SOUTH POLE AND WSC SPTR FILE SERVERS

Testing

- The GSFC Test Bed at Building 25 will be utilized to mock-up the South Pole equipment and the WSC equipment.
- Testing will be done via TDRS-F1 if time is available in September
  - SSAR Transmit BER testing
  - SSAF Receive BER testing
- NISN will perform the testing and certification of the WSC routers after installation.
- South Pole testing is scheduled for December after installation
  - RF system testing
  - Fileserver testing

SYSTEM DESIGN

High-Level Requirements

- Full Duplex Connectivity / Interactivity
  - Allow Internet access to the South Pole Station
  - Allow researcher's to monitor and control their South Pole based experiments remotely
  - TCP/IP protocol to provide the real-time interaction
- Time of connection
  - Use of TDRS-F1 closes the gap between LES-9 and GOES-3
  - TDRS-F1 time increases as inclination grows
- Bandwidth and throughput
  - The AMANDA project has a growing need for bulk data (GBytes/day) to be transmitted
  - The Smithsonian Astrophysical Observatory 10M Telescope will require additional bandwidth
- Minimal staffing requirements

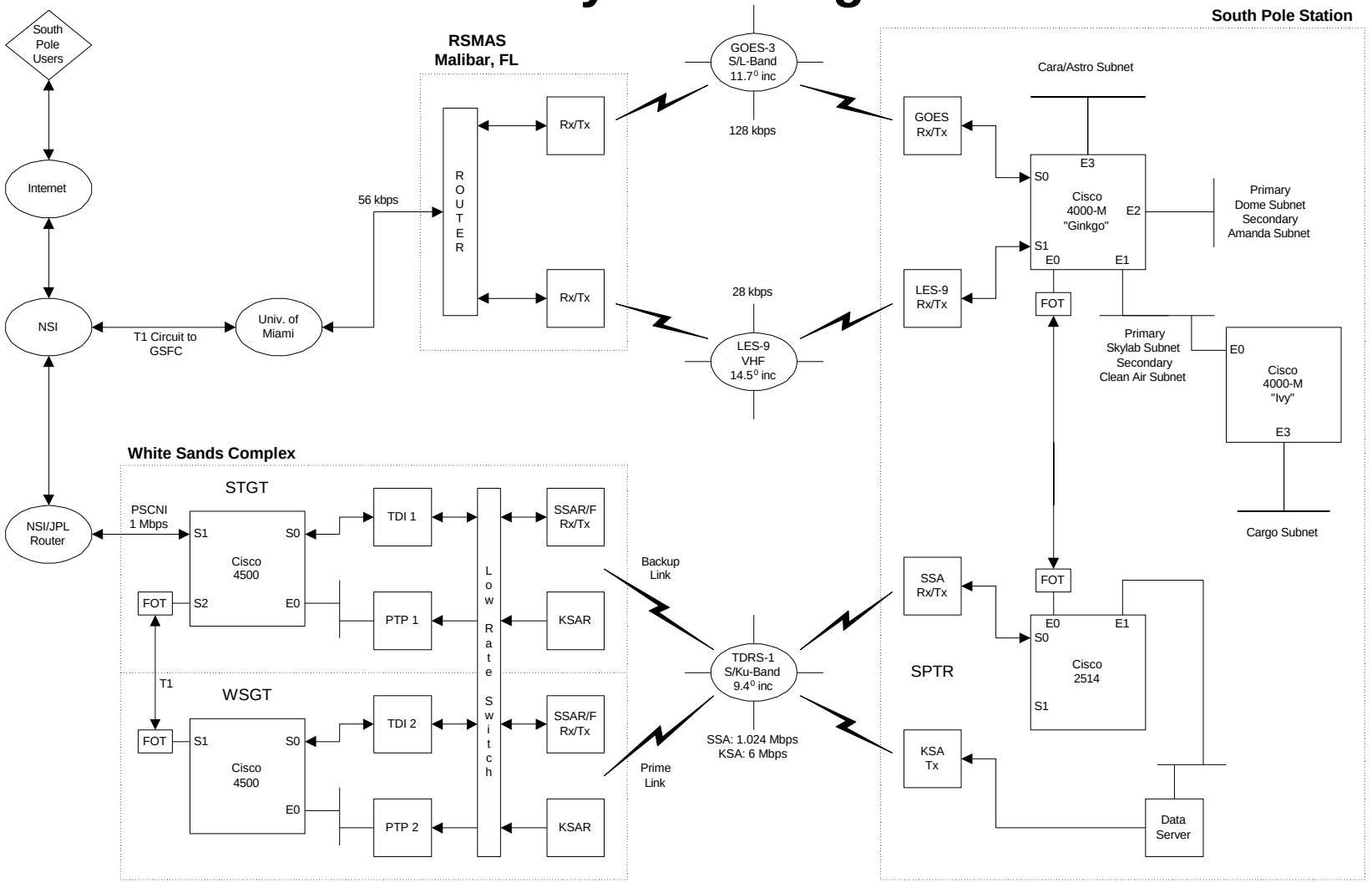
Assumptions and Constraints

- Assumptions
  - The TDRS-1 spacecraft will continue in service for an extended period of time
  - NASA will provide long term TT&C facilities support for the TDRS-1 spacecraft
  - NASA will assist NSF in developing and testing the proof of concept system

- Constraints
  - Limitations on mechanical devices exposed to ambient temperatures.
  - Relative humidity of 3% max
  - Altitude of 3280 meters (10,700 ft average)
  - Low elevation angle will require antenna design and placement considerations
  - Oblique view of satellite through the atmosphere may cause link margin losses and multipathing effects, requiring compensation in South Pole ground antenna.
  - Pointing update to the South Pole ground antenna approximately every 6 months.
  - Electromagnetic interference control for off-boresight emission spill-over into Dark Sector may require special antenna design considerations.
  - Limited utility power
  - Limited maintenance and operations staff

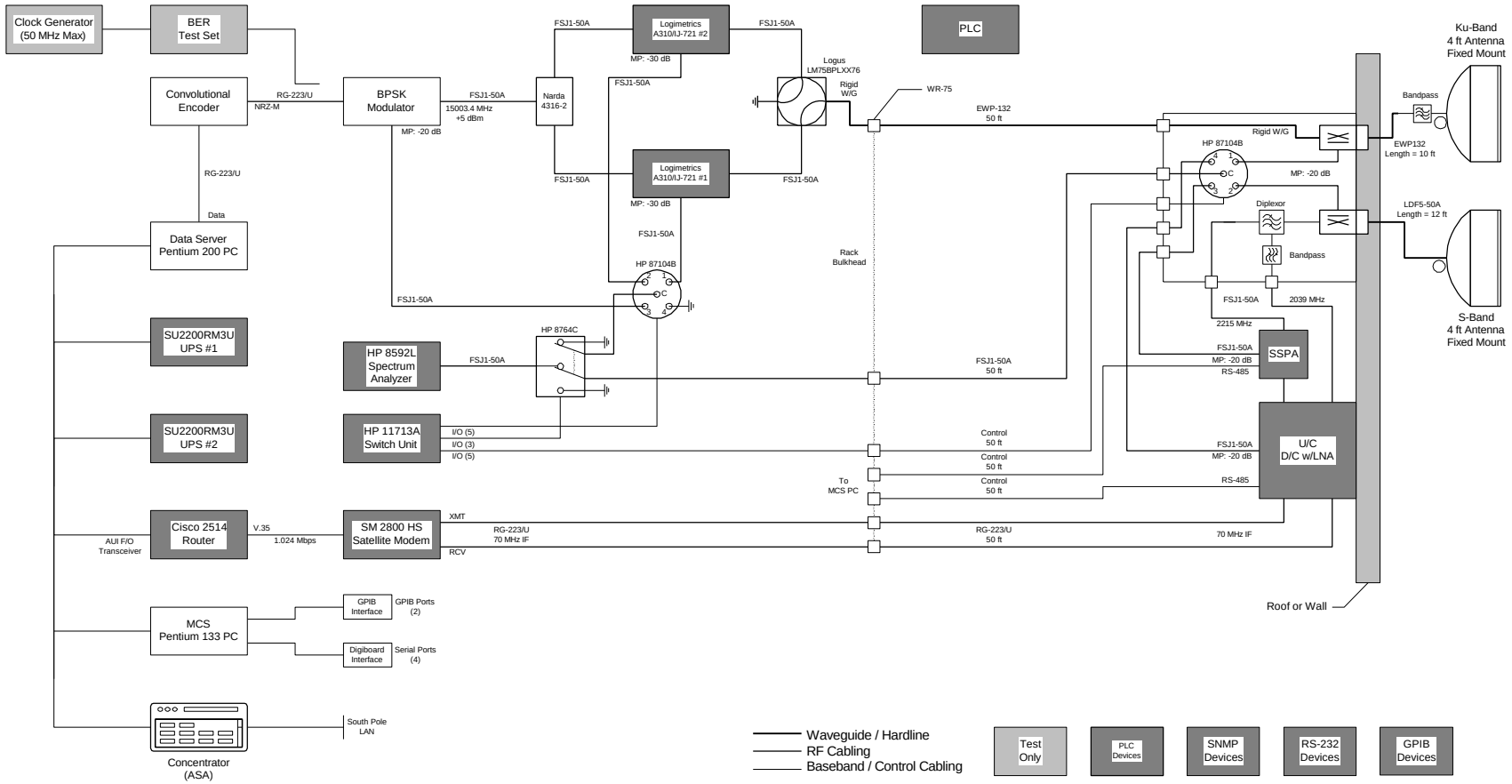
South Pole TDRSS Relay (SPTR)

SPTR System Diagram



South Pole TDRSS Relay (SPTR)

South Pole Relay Terminal



Hardware Design

- System summary
  - Four Subsystems
    - » TDRS Interface Subsystem
    - » Baseband Equipment Subsystem
    - » Monitor and Control Subsystem
    - » WSC/User Interface Subsystem
  - Six Hardware Configurations Items
  - One Computer Software Configuration Item
  - Two racks of equipment at the South Pole Station
    - » One for Ku-Band equipment
    - » One for S-Band equipment
  - Two racks of equipment at WSC
    - » Prime String: One rack for PTP, TDI, and router at WSGT
    - » Backup String: One rack for PTP, TDI, and router at STGT
  - Antennas:
    - » One Ku-Band 4 foot fixed mount antenna, transmit only
    - » One S-Band 4 foot fixed mount antenna, transmit and receive capability
  - Shared facility with the GOES System currently installed at South Pole
  - The security vulnerability assessment (VA) for the SPTR has been approved by the Division ITSO and the Directorate ITSO

TDRS Interface Subsystem

- Ku-Band Design Summary
  - Sufficient link margins for TDRS-F1 KSAR support at 50 Mbps
  - Modified COTS antenna from vendors with Antarctic experience
    - » Gabriel Electronics is supplying the antenna (MTRS System)
    - » Seavey Engineering is supplying the CP feed (GOES System)
  - Filtering to minimize impact on scienific experiments and research
  - TWTA's are from WSC excess and have been verified by OEM (Logimetrics)
- Risk Areas
  - Schedule and Installation window
  - Partial redundancy and sparing
- Open Issues
  - TWTA montior and control
    - » Plan is PLC control identical to unit installed at GRTS in 1993
    - » Quote being obtained from Logimetrics for comparison
  - Some signal refraction is expected
    - » This will require repointing approximately every six months
  - Significant multipathing is not expected

TDRS Interface Subsystem

- S-Band Design Summary
  - Sufficient link margins for TDRS-F1 SSAR and SSAF support
  - Modified COTS antenna from vendors with Antarctic experience
    - » Gabriel Electronics is supplying the antenna (MTRS System)
    - » Seavey Engineering is supplying the CP feed (GOES System)
  - Filtering to minimize impact from GOES System transmit frequency
  - Integrated Up/Downconverter with LNA and SSPA from Miteq
    - » Similar to units installed in MTRS in 1995
    - » Different packaging scheme allows greater flexibility
- Risk Areas
  - Schedule and Installation window
  - Up/Downconverter schedule
  - No redundancy or sparing
- Open Issues
  - None

Baseband Equipment Subsystem

- Design Summary
  - BPSK Modulator is second generation from MTRS and 5th production unit
  - Convolutional Encoder is a standard design
    - » Unit available in early October for testing
  - Intel Pentium 200 to provide Data Server duties
    - » Target bulk dump rate of 6 Mbps for first year
    - » Telemetry board from Avtec
  - Intelsat standard Satellite Modem for modulation and demodulation
    - » Identical to unit currently used by GOES System except higher data rate
  - Industry standard Cisco router for South Pole LAN connection
- Risk Areas
  - Schedule and Installation window
  - Partial redundancy and sparing
- Open Issues
  - None

Monitor and Control Subsystem

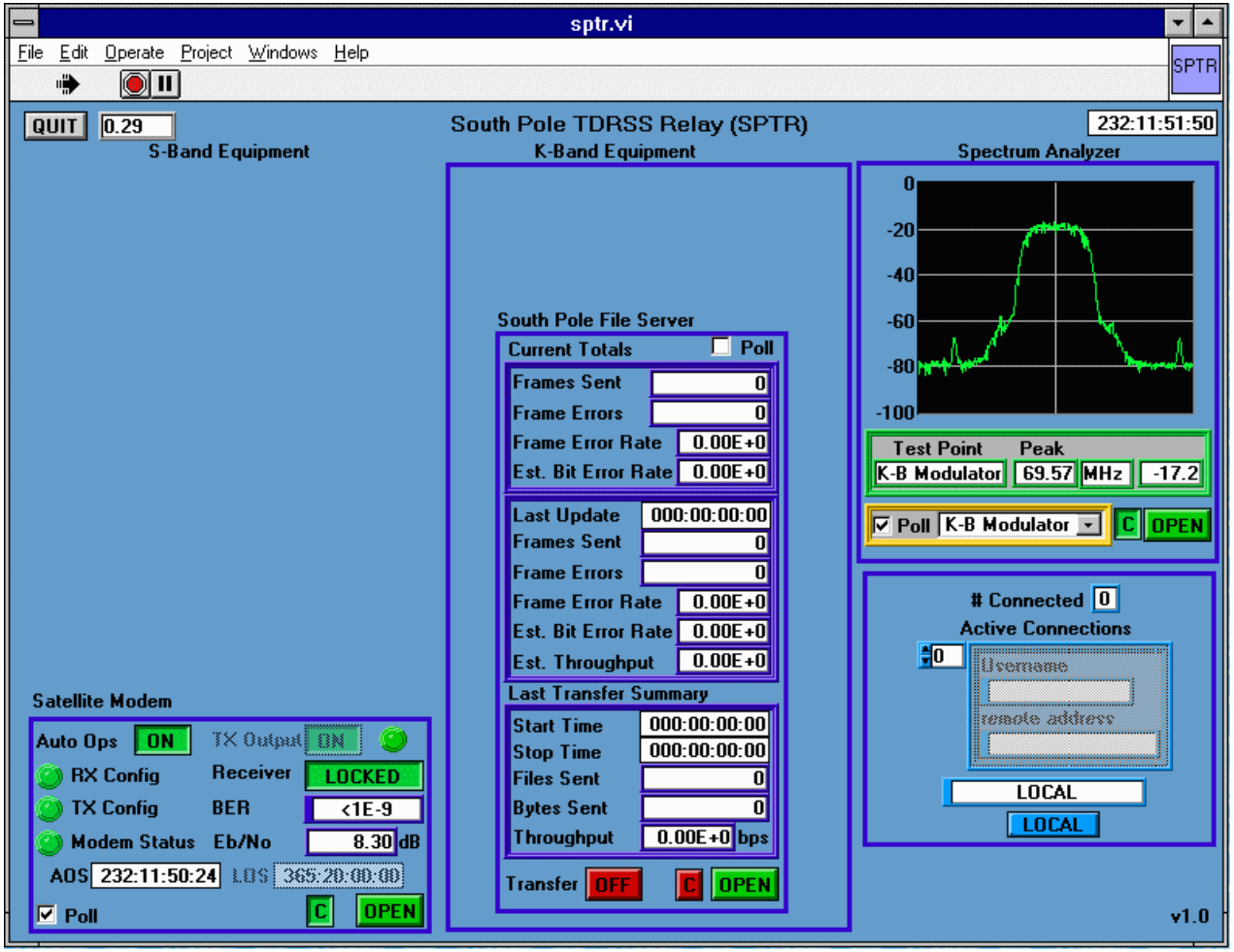
- Design Summary
  - Flexible design allows for future expansion
  - All equipment is COTS industry standard
  - COTS process control software (LabView)
  - Standards based control (EIA/TIA, ISO, RFCs)
  - Design done from TURFTS, MTRS, and GRTS experience
  - Compatible with TURFTS and MTRS automation efforts
  - Allows networked remote access for on-station support as well as CONUS support
- Risk Areas
  - Schedule and Installation window
  - Minimal redundancy and sparing
- Open Issues
  - TWTA monitor and control

MCS Software Design

- Summary
  - SPTR will use LabView 4 process control software by National Instruments
    - » Widely available commercial software package
    - » Runs under Microsoft Windows NT
    - » Minimal development of drivers, SNMP driver only
    - » Project can utilize software interfaces developed for TURFTS and MTRS
  - High level design has been completed
  - Detailed coding with equipment has begun
  - Full integration and testing at BLT
- Risk Areas
  - Schedule and Installation window
- Open Issues
  - TWTA monitor and control

South Pole TDRSS Relay (SPTR)

SPTR Main Screen



South Pole File Server

- South Pole
  - Hardware:
    - » Intel Pentium 200
    - » 2 GB Ultra-Wide SCSI drive, Avtec Serial I/O comm board
    - » Windows NT Operating System
  - Software:
    - » Custom application to send files to WSC server.
  - Protocol:
    - » Acceptance of socket connection and ready flag that WSC fileserver is receiving idle pattern
    - » South Pole server reads one file at a time in one directory, “telemetrizes” the file, and begins transmission.
    - » WSC server will send frame counter ids needed for retransmission to complete the file transfer. Once a file is successfully transferred, it will be deleted.
    - » Transfer continued until every file sent. Idle pattern is sent after last file transmission.
    - » If new file is found and ready flag from WSC fileserver received, then process repeats.

WSC/User Interface Subsystem

- Design Summary
  - One full string of equipment at WSGT (Prime)
  - One full string of equipment at STGT (Backup, can be used as prime spares)
- Risk Areas
  - No redundancy but some spares available
- Open Issues
  - None

WSC File Server

- WSC
  - Hardware:
    - » Programmable Telemetry Processor (PTP)
      - Pentium
      - Windows NT / IBM OS/2
      - 2 GB Ultra-Wide SCSI Drive (for sptr), 1GB Ultra-Wide SCSI Drive (for DAS), Avtec Serial I/O comm board (3)
  - Software:
    - » Custom application to receive files from South Pole Server and PTP software (OS/2 and Windows NT Versions).
  - Protocol:
    - » Look for idle pattern.
    - » Once found, open connection to South Pole server and send ready flag.
    - » Ingest files, one “frame” at a time, keep track of frame counter.
    - » If frame counter indicates frame drop, send message to South Pole server.
    - » When file completely received and no more dropped frames store file in one directory and signal south pole for next file.
    - » Continue listening for files until idle pattern has started. Send ready flag on repetitive basis, assuming idle pattern is continuous.

Facilities

- Summary
  - SPTR is to be co-located in the Elevated Dorm with the GOES System
  - Minimal equipment will be exposed to the outside environment
    - » S and Ku-Band antennas
    - » Ku-Band filter, waveguide, and S-Band foamflex cabling
  - Diplexer and S-Band filter located at building penetration but inside
  - Up/Downconverter, SSPA, and LNA located alongside Diplexer
    - » Maintains low system noise for receive string
    - » Provides minimal loss on transmit string
    - » U/C-D/C signals are 70 MHz which allows greater flexibility due to reduced cabling losses
  - Wall or ceiling space required for Hoffman box and Transceiver box
  - Room plan in progress
    - » Draft floor plans delivered by ASA
    - » Power requirements, ventilation, and access issues have been identified
  - Final plan under development
- Risk Areas
  - SPTR must transmit over a corner of the Dark Sector to 49^0W longitude
- Open Issues
  - Providing for ease of repointing the Ku-Band antenna in the future

ISSUES / CHALLENGES AND MITIGATION

South Pole TDRSS Relay (SPTR)

Issues

Issue	Mitigation
Project Schedule	- Maximize usage of GFE equipment - Minimize new hardware and software development * No custom designs * Capitalize on lessons learned from MTRS * Utilize process control software - Use of existing facilities and infrastructure at South Pole Station - Complete I&T of system at GSFC prior to shipment.
Logistics/Shipping/ Transportation	- Planning and scheduling with NSF and ASA is in progress - Project costs to ship to Christchurch, NZ are included - Key dates for shipment are being established
S-Band Interference from GOES System	- GOES transmit at 2027 MHz and SPTR receive at 2039 MHz * Filtering will be required. * Analysis and specifications for the filter have been developed * The filter is being procured for the SPTR SSAF string
Ku-Band Carrier Frequency Harmonics	- SPTR second harmonic from 15003.4 MHz is the issue * Filtering will be required. * Analysis and specifications for the filter have been developed * The filter is being procured for the SPTR KSAR string > RF SOC has a filter that is being tested > Filter has a cut-off at 15250.0 MHz
Longevity of TDRS-F1	- Flight 1 is 14 years old, requires constant TT&C support, and has some lost functionality - Long term TT&C is issue when H, I, and J are launched * GRTS will be decommissioned and removed from Australia in late 1998 - Flight 3 inclination is approximately 3.5 degrees, greater than 9 degrees is required - A long term strategy for a TDRS-F1 replacement is required
Installation Process and Schedule	- Minimal time is available at South Pole due to strict time budget requirements - I&T will be done at GSFC to minimize on-site "as built" changes - Testing window will be approximately 2.5 hours per day with WSC - Planned testing will be required to maximize time productivity

Issues, cont'd

Issue	Mitigation
Telephone access while on-station	- ATS-3 service is available during all TDRS test times * Radiophone access has been discussed with NSF and requested for test support - Voice over Internet service is being invetigated to allow the Internet access to provide service once the S-Band link is installed.
Environmental	- Winter months are dark with temperatures below -100F. * Environmental specifications stressed to vendor's of equipment place outdoors. * Vendor's of outdoor equipment all have previous Antarctic experience.
Remote System Access	- LabView software being utilized to control system - Network access is built in for remote system monitor and control - A run-time executable program will allow access to the system from any PC on the LAN.

PROJECT SCHEDULE

South Pole TDRSS Relay (SPTR)

Design / Development

Creation Date: 4/10/97	South Pole TDRS Relay Project Schedule																																Code: 531
Last Revision Date: 8/19/97	May				June				July				August				September				October				November				December				January
Task Name	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Project Start	◆																																			
Full Funding					◆																															
Design Phase	├												┤																							
System Design	├																																			
Subsystem/HWCI	├												┤																							
WSC/NISN	├												┤																							
Status Review																◆																				
Procurement								├																				┤								
Order Parts								├								▽																				
Monitor/Receive Parts									├							▽																				
Software Development									├																				┤							
Write Software									├							▽																				
Unit Test Software										├						▽																				
Integration and Testing, BLT													├															┤							
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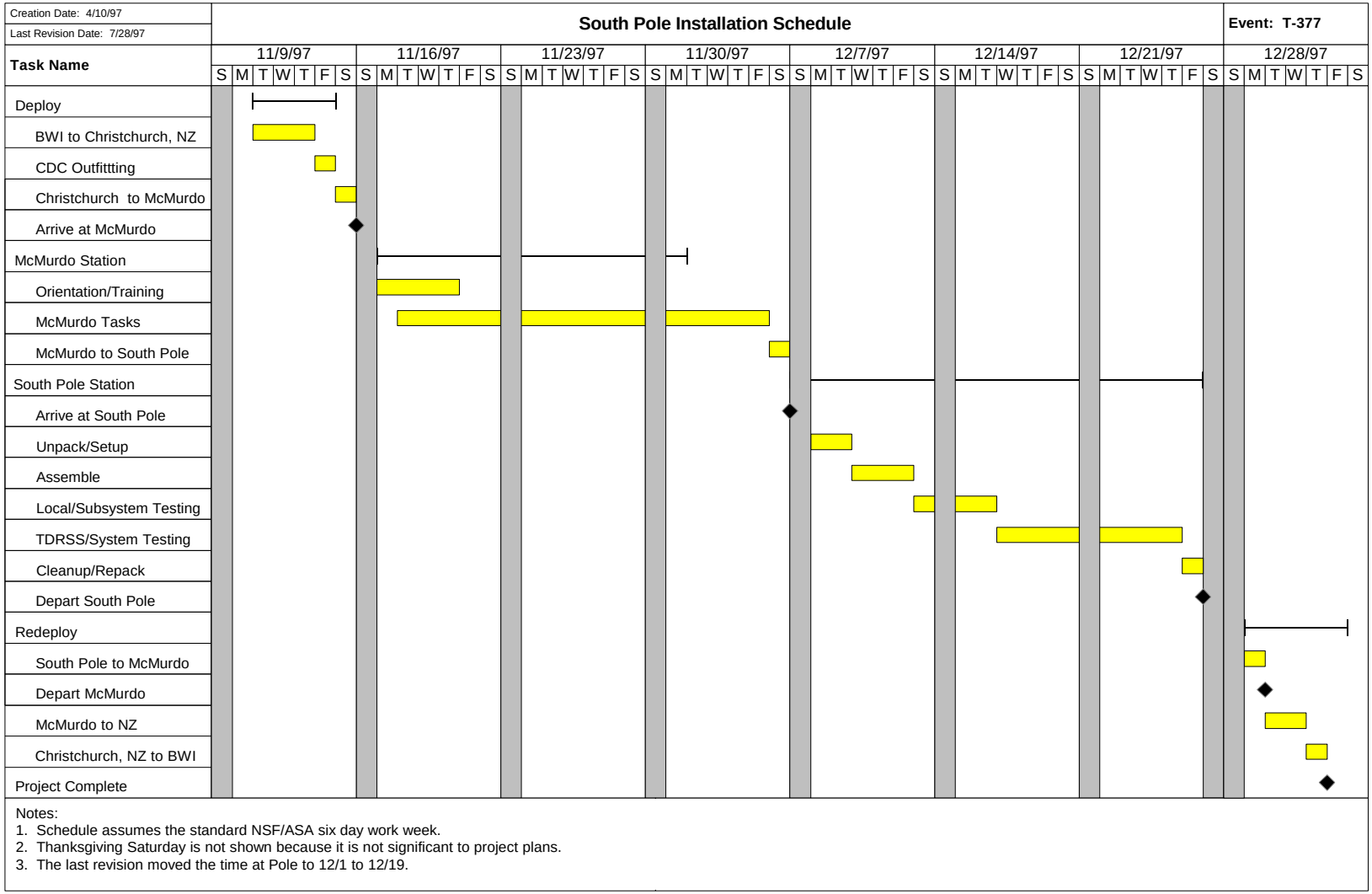
Subsystem Testing																					├															
System Testing																						├														
Pack & Ship																									├											
Disassemble																										├										
Pack																											├									
Ship to ASA, NZ																												├								
Installation at South Pole[1]																													├							
Installation at WSC[2]																														├						
Documentation								├																												
Operations Concept								├								▽																				
ICD's																		├																		
Technical Manual																			├																	
EC								├								▽																				
Project Complete																																	◆			

Notes:
1. South Pole Installation Schedule is shown separately.
2. WSC installation schedule is under development.

South Pole Installation



Notes:
1. Schedule assumes the standard NSF/ASA six day work week.
2. Thanksgiving Saturday is not shown because it is not significant to project plans.
3. The last revision moved the time at Pole to 12/1 to 12/19.

HARDWARE STATUS

Ku-Band Equipment

HWCI	Description	P/N	FSN	Qty	Mfg	Order	ARO	RCV
1.00	**Ku-Band**							
1.01	Antenna, 4 ft, w/Radome	SR4-144CSE	5985-00-N97-1956	1	Gabriel	Y	8/13	
1.02	Feed, Antenna	AS48-1515C	5985-00-N97-1957	1	Seavey	Y	9/18	
1.03	Mount, Antenna			1	ATSC	Y	12/1	
1.04	HPA, 20W	A310/IJ-721		2	GFE, Logimetrics	Y	8/29	
1.05	Switch, RF	LM75BPLXX76		2	GFE, Logus	na	na	X
1.06	Attenuator, Pin Diode	D1958	5985-00-R95-1171	1	General Microwave	Y	7/9	X
1.07	Coupler	C16995G1		1	Neico	na	na	X
1.08	Filter, Bandpass			1	MDL			
1.09	Termination, WR-75	C17028G1		3	GFE, Neico	na	na	X
1.10	Adapter, WR-62 to 75	25490G1		1	GFE, Lucas Epsco	na	na	X
1.11	RF Load, Medium Power	7582-S-13		1	GFE	na	na	X
1.12	PLC			1	Omron			

- One Ku-Band TWTA has been repaired and tested by Logimetrics.
- One Ku-Band TWTA is being repaired and tested by Logimetrics.
- Bandpass filter being tested by the RF SOC.
- Control of the TWTA's is being designed around PLCs.

S-Band Equipment

HWCI	Description	P/N	FSN	Qty	Mfg	Order	ARO	RCV
2.00	**S-Band**							
2.01	Antenna, 4 ft, w/Radome	RF4W-19SE	5985-00-N97-1958	1	Gabriel	Y	8/13	
2.02	Feed, Antenna	AS48-22C	5985-00-N97-1959	1	Seavey	Y	9/18	
2.03	Mount, Antenna			1	ATSC	Y	12/1	
2.04	Diplexer, Coaxial	S253-1		1	GFE, Wavecom	na	na	X
2.05	Up/Downconverter	U/D-100-xxxxx	7025-00-R97-1004	1	Miteq	Y	10/23	
	NRE		--	1	Included	--	--	--
	LNA	Option 25	--	1	Included	--	--	--
	SSPA, 10W	Option 1D	--	1	Included	--	--	--
2.06	Line Coupler, Coaxial	S-910-30-S4		1	GFE, Wavecom	na	na	X
2.07	Filter, Bandpass			1	K&L			
2.09	RF Load	N9550		1	GFE, ARRA	na	na	X

- Up/Downconverter is long-lead item, delivery in late October/early November.
- No other issues.

Baseband Equipment

HWCI	Description	P/N	FSN	Qty	Mfg	Order	ARO	RCV
3.00	**Baseband**							
3.01	Satellite Modem	SM2800HS	7025-00-N97-1960	1	Fairchild	Y	9/10	X
3.02	Convolutional Encoder			3	NASA/ATSC	Y	10/8	
3.03	Modulator			1	NASA/ATSC	Y	10/15	
3.04	Dual Channel Router	2514		2	Cisco	NISN	9/16	
	Memory	MEM1X8F		2	Cisco	NISN	9/16	
	V.35 Cables	CAB-V35T		4	Cisco	NISN	9/16	
	Enterprize Software	SF25A-11.2.2		2	Cisco	NISN	9/16	
3.05	Chassis, Rackmount	RM060	5975-00-N95-3297	1	MultiMicro Systems	Y	7/21	
3.06	Power Supply	PS230ATX	6130-00-N97-1961	2	JDR Microdevices	Y	7/2	X
3.07	Intel Pentium 200	1470 Titan	7025-00-R97-1037	1	Global Micro	Y		
3.08	Memory, 72 pin SIMM	EDO 4x32-72 Pin	7025-00-N95-7578	2	Compustar	Y	7/2	X
3.09	Video Card	Stealth 64-2VR	7025-00-N93-6879	1	BCD Computers	Y	7/28	X
3.10	Ethernet Card	NW3C900COM	7025-00-N96-2776	1	Insight	Y	6/30	X
3.11	Telemetry Board	AT3037	7025-00-N97-1981	1	Avtec	Y	8/15	X
3.12	Disk Drive, 2.1 GB, SCSI	WD E2170	7025-00-N97-6066	2	Aberdeen	Y	7/1	X
3.13	Disk Drive, 1.44 MB	FD-235HF	7025-00-N96-3232	1	Teac	Y	7/7	X
3.14	Drive, CD, SCSI	Toshiba 12X	7025-00-R96-3041	1	Compustar	Y	7/31	
3.15	Controller, SCSI, PCI	Adaptec 2940UW	7025-00-R97-1032	1	Patriot Systems	Y	7/28	X
3.16	Drive, Tape, DAT, 2.0 GB	Conner 4320	7025-00-N96-1410	1	Bason	Y	7/7	X
3.17	Keyboard, Rackmount	KBD-R101TB	7025-00-N97-1962	1	JDR Microdevices	Y	7/2	X
3.18	Monitor Enclosure, 15"	RE19-M14	7025-00-N97-1963	1	JDR Microdevices	Y	7/2	X
3.19	Monitor, 1280x1024	15GS	7025-00-N97-7470	1	Hi Tech/Viewsonic	Y	7/2	X
3.20	Tapes, DAT Format	D4MM-90	7045-01-362-6562	5	NASA/ATSC	Y	7/28	X

- Unexpected lengthy delays in procuring computer parts is hindering integration and software development efforts.

Monitor and Control System

HWCI	Description	P/N	FSN	Qty	Mfg	Order	ARO	RCV
4.00	**Monitor & Control H/W**							
4.01	Chassis, Rackmount	RM060	5975-00-N95-3297	1	MultiMicro Systems	Y	7/21	
4.02	Power Supply	PS230ATX	6130-00-N97-1961	2	JDR Microdevices	Y	7/2	X
4.03	Intel Pentium 133	Intel Pentium 133	7025-00-N97-1952	1	GFE	Y	7/1	X
4.04	Memory, 72 pin SIMM	EDO 4x32-72 Pin	7025-00-N95-7578	2	GFE	Y	7/1	X
4.05	Video Card	Stealth 64-2VR	7025-00-N93-6879	1	GFE	Y	7/1	X
4.06	Ethernet Card	NW3C900COM	7025-00-N96-2776	1	GFE	Y	7/1	X
4.07	GPIB Adapter	5998-00-R93-1146	5998-00-R93-1146	1	National Instruments	Y	7/1	X
4.08	Drive, Disk, IDE, 2.1 GB	AC32100	7025-00-N96-1586	2	GFE	Y	7/1	X
4.09	Disk Drive, 1.44 MB	FD-235HF	7025-00-N96-3232	1	GFE	Y	7/1	X
4.10	Drive, CD-ROM, IDE	Toshiba 12X		1	Toshiba	Y	7/1	
4.11	Keyboard, Rackmount	KBD-R101TB	7025-00-N97-1962	1	JDR Microdevices	Y	7/2	X
4.12	Monitor Enclosure, 15"	RE19-M14	7025-00-N97-1963	1	JDR Microdevices	Y	7/2	X
4.13	Monitor, 1280x1024	15GS	7025-00-N97-7470	1	Hi Tech/Viewsonic	Y	7/2	X
4.14	Digiboard & Card	21068-36	5999-00-N95-1448	1	GFE	na	na	X
4.15	Spectrum Analyzer	HP 8592L	6625-00-N96-1624	1	Hewlett-Packard	Y	8/25	
4.16	HPIB Interface	OPT-041	--	--	Hewlett-Packard	Y	8/25	
4.17	Calibration Certificate	OPT-UK6	--	--	Hewlett-Packard	Y	8/25	
4.18	Attenuator/Switch Unit	HP11713A	6625-01-081-4153	1	Hewlett-Packard	Y	7/9	X
4.19	Cable, Switch	HP-8120-2703	5995-00-N96-1921	2	GFE - HP	na	na	X
4.20	Test Port Switch	HP8764B	5930-00-N97-1968	1	Hewlett-Packard	Y	7/11	X
4.21	RF Switch	HP87104B	5930-00-N96-1030	2	Hewlett-Packard	Y	7/10	X
4.22	Solder Terminals	OPT 100	--	0	Hewlett-Packard			

- Unexpected lengthy delays in procuring computer parts is hindering integration and software development efforts.

Racks and Cabling

HWCI	Description	P/N	FSN	Qty	Mfg	Order	ARO	RCV
5.00	**Racks and Cabling**							
5.01	Rack			2	ASA / GFE	na	12/1	X
5.02	Smart-UPS 2200	SU2200RM3U	5975-00-R97-1121	2	Control Cabling (APC)	Y	8/23	X
	Network Module			2	Control Cabling (APC)			
5.03	Power Strip	IBR-12	6130-00-N94-0599	2	Allied Electronics	Y	7/7	X
5.06	Panels, Blank			9	GFE	na	na	na
5.07	Enclosure	96F4627	5975-00-R97-1087	1	Hoffman	Y	8/1	X
5.08	Panel, Aluminum	7110-00-N95-1844	7110-00-N95-1841	1	Hoffman	Y	7/21	X
5.09	Fan			6	GFE	na	na	X
5.10	Waveguide, Inside Run	EWP-132		50	GFE, WSC	na	na	
5.11	Waveguide, Outside Run	EWP-132		10	GFE, WSC	na	na	
5.12	Flange, Bulkhead, WR-75			3	GFE, GARF	na	na	
5.13	Connector, N, Bulkhead			15	GFE, GARF	na	na	
5.14	Power Divider, 2 Way, SMA, 12-18 GHz	4316-2	6625-01-185-1848	2	Narda	Y	7/15	X
5.21	Cable, 1/4" Superflex	FSJ1-50A	6145-00-N91-8464	200	Andrew	Y	7/21	X
5.22	Connectors, SMA	F1PSM-H	5935-00-N95-1716	25	Andrew	Y	7/21	X
5.23	Connectors, N	F1PNM-H	5935-00-N93-9579	25	Andrew	Y	7/21	X
5.24	Cable, Coaxial	RG-223/U		500	GFE - Alpha	na	na	X
5.25	Connectors, SMA	901-9511-1SFC	5935-00-R97-1033	20	Amphenol	Y	7/21	X
5.26	Connectors, BNC, Plug	2-329444-2	5935-00-701-5318	40	Amp	Y	7/11	X
5.27	Jumper, F/O, ST-ST, 60 ft	J22BB60F	5995-00-N95-1764	4	Fiber Connections	Y	7/28	X
5.28	Cables GPIB, 6 ft	763061-03	6145-00-N92-3797	5	National Instruments	Y	7/21	X
5.29	Cables RS-232, 9 ft	RSEC-904-9	5995-00-N95-1752	5	SPC Technology	Y	7/22	X
5.30	Labels, Cable	PDL-2	7530-00-R95-1425	1	Panduit	Y	7/21	X

- No issues.

White Sands Complex

HWCI	Description	P/N	FSN	Qty	Mfg	Order	ARO	RCV
6.00	**WSC H/W**							
6.01	PTP			1	GFE/DAS - Avtec	na	GSFC	X
6.02	Dual Channel Router	4500-M		2	Cisco	NISN	9/16	
	Adapter, 2 Enet	NP-2E		2	Cisco	NISN	9/16	
	Adapter, 4 Serial Port	NP-4T		2	Cisco	NISN	9/16	
	V.35 Cables	CAB-V35T		8	Cisco	NISN	9/16	
	RS-449 Cables	CAB-449MT		4	Cisco	NISN	9/16	
	Enterprize Software	SF4A-11.2.2		2	Cisco	NISN	9/16	
6.03	TDRSS Data Interface			3	NASA/ATSC	Y	10/1	

- The PTP is being tested at GSFC.
- The TDRSS Data Interface is being developed by NASA/ATSC.
- No other issues.

Software

CSCI	Description	P/N	FSN	Qty	Mfg	Order	ARO	RCV
1.00	**Monitor & Control S/W**							
1.01	Windows NT 4.0	Windows NT 4.0	7030-00-S96-3972	1	Microsoft	Y	7/10	X
1.02	Windows NT 4.0	Windows NT 4.0	7030-00-S96-3972	1	Microsoft	Y	7/25	X
1.03	Labview	776670-03	7030-00-S95-3004	1	GFE, National Instruments	na	na	X
1.04	C++ Developer	7030-00-S96-1265	7030-00-S96-1265	1	Borland	Y	8/1	X
1.05	PC Anywhere	7030-00-S96-1192	7030-00-S96-1192	1	Symantec	Y	7/10	X

- All OS and development software is in house.

PROJECT BUDGET

South Pole TDRSS Relay (SPTR)

Budget Allocations

Item	Subtotal Cost	ATSC	RSSC
HWCI			
1.0 Ku-Band	$12,625	$1,000	$11,625
2.0 S-Band	$40,030	$1,000	$39,030
3.0 Baseband	$95,428	$75,000	$20,428
4.0 MCS Hardware	$27,722	$0	$27,722
5.0 Racks and Cabling	$7,086	$0	$7,086
6.0 WSC/NISN	$45,752	$20,000	$25,752
** Subtotal	$228,643	$97,000	$131,643
CSCI			
1.0 Software	$1,151	$0	$1,151
Labor	$50,000	$50,000	$0
Shipping to NZ	$10,000	$0	$10,000
Total Cost	**$289,793**	**$147,000**	**$142,793**
Contingency	**$10,207**	$3,000	$7,207
Project Total / Split	**$300,000**	$150,000	$150,000

PROJECT SUMMARY

Summary

- The system architecture is flexible to allow multiple customers.
- Major risks have been identified.
- Link margins indicate a robust system.
- Procurement is approximately 80% complete.
- Proof-of-concept system development is well underway.
- Integration and testing efforts will be starting in early September.

- The schedule is extrememly tight with only one week available for installation slip. Smart planning of integration and testing is being utilized to mitigate any schedule slips. Testing will be prioritized to accomodate South Pole first and WSC and other CONUS equipment second. These actions should ensure the successful installation of the proof-of-concept system during the 1997/1998 season.

ACRONYMS

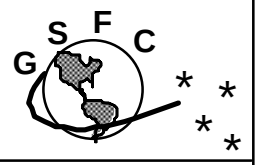
Acronym List

AMANDA	Antarctic Muon and Neutrino Detector Array
ANSI	American National Standards Institute
ASA	Antarctic Support Associates
ASTM	American Standards for Testing Methods
ATS-3	Applications Technology Satellite 3
ATSC	AlliedSignal Technical Services Corpora tion
CARA	Center for Astrophysical Research in Antarctica
CONUS	Continental United States
COTS	Commercial-off-the-shelf
DCE	Data Computer Equipment
DNS	Domain Name Service
DTE	Data Terminal Equipment
EIA	Electronic Industries Association
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EMS	Electromagnetic Susceptibility
ESD	Electrostatic Discharge
FM	Frequency Modulated
FTP	File Transfer Protocol
GPS	Global Positioning System
HF	High Frequency
HPA	High Power Amplifier
IEEE	Institute of Ele ctrical and Electronics Engineers
IETF	Internet Engineering Task Force
ISO	International Standards Organization
ITU	International Telecommunications Union
Kb	Kilobit
Kbps	kilobits per second
KSA	K-Band Single Access
kW	Kilowatt
LAN	Local Area Network
LES-9	Lincoln Experimental Satellite 9
LNA	Low Noise Amplifier
Mb	Megabit
Mbps	Megabit per second
MCS	Monitor and Control System
MTRS	McMurdo TDRS Relay System
NASA	National Aeronautics and Space Administration
NIST	National Institute of Science and Technology
NSF	National Science Foundation
O&M	Operations and Maintenance
OS	Operating System
OSI	Open Systems Interconnection
PLC	Programmable Logic Controller
RF	Radio Frequency
RFC	Request For Comment
RFI	Radio Frequency Interference
RSMAS	Rosenstiel School of Marine and Atmospheric Sciences
SCSI	Small Computer System Interface
SGL	Space to Ground Link
SNMP	Simple Network Management Protocol
SSA	S-Band Single Access
SSPA	Solid-State Power Amplifier

Acronym List

TCP/IP	Transmission Control Protocol and Internet Protocol
TDRS	Tracking and Data Relay Satellite
TDRSS	Tracking and Data Relay Satellite System
TIA	Telecommunications Industry Association
TT&C	Tracking, Telemetry, and Command
UDP	Universal Datagram Protoc ol
UHF	Ultra High Frequency
UPS	Uninterruptible Power Supply
USAP	United States Antarctic Program
VHF	Very High Frequency
WAN	Wide Area Network

South Pole TDRSS Relay (SPTR)



BACKUP MATERIAL

Background

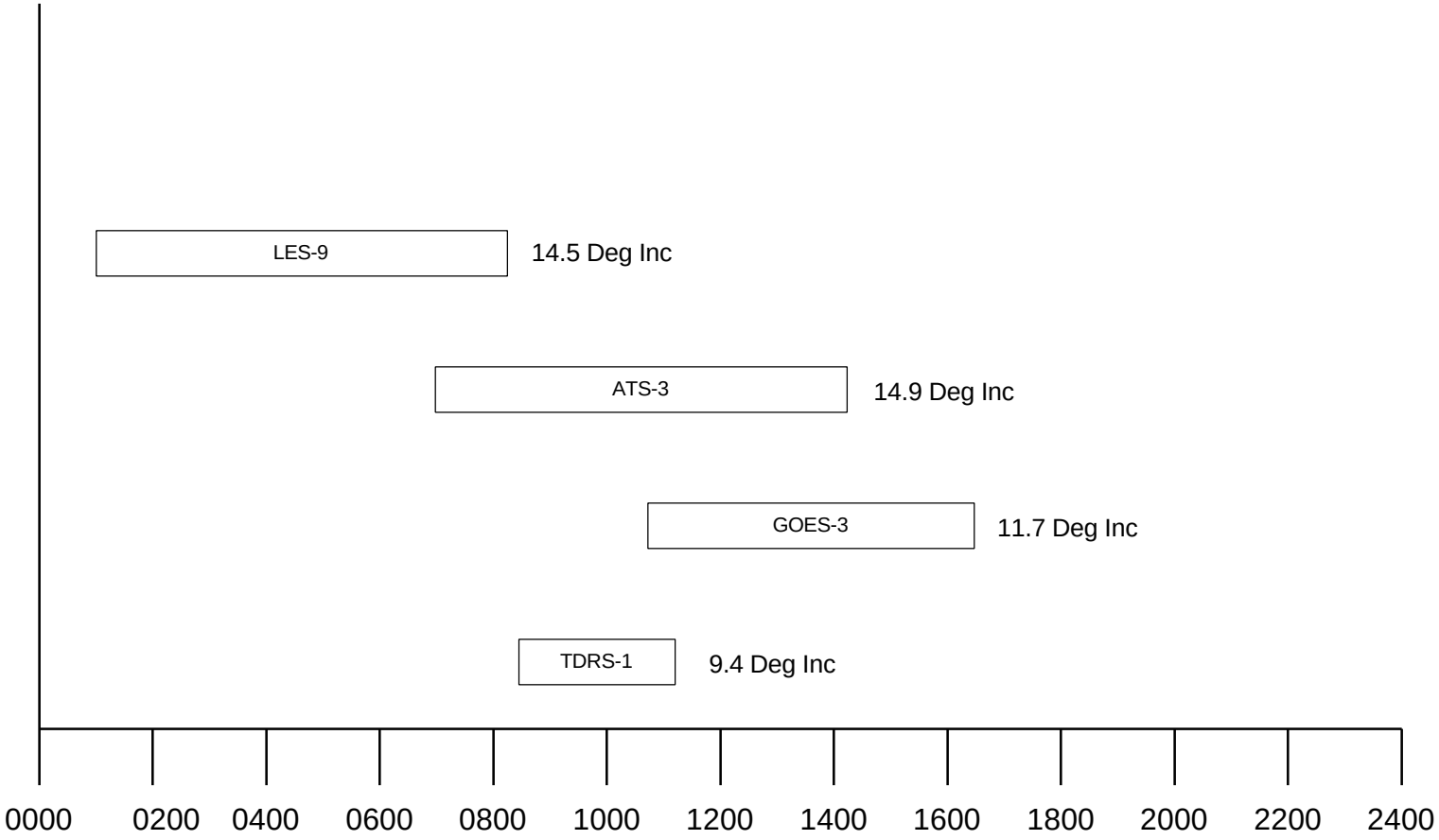
- Excerpt from “Electronics Systems Major Systems Concepts Definition for Cost Estimation”, by the National Science Foundation.

  With the recent development of the Science and Technology Center for Astrophysical Research in Antarctica (CARA) and the Antarctic Muon and Neutrino Detector Array (AMANDA), the demand for intercontinental communications - high speed data - has increased significantly. CARA and AMANDA provide observatories at the South Pole with instrumentation designed to probe the outer reaches of the universe. These instruments generate large quantities of imaging and signal data which must be transmitted to CONUS for processing, reduction, and analysis. **The quantity of data to be transmitted daily is sufficient that a very high speed, 45 Mbps, data relay is required.** Additionally, the Smithsonian Astrophysical Observatory has proposed the development of a world-class submillimeter-wave telescope (10 meter aperture) as a long term astrophysical observatory at South Pole Station, circa the year 2003-2004. If approved, this will further increase the need for advanced data communications.

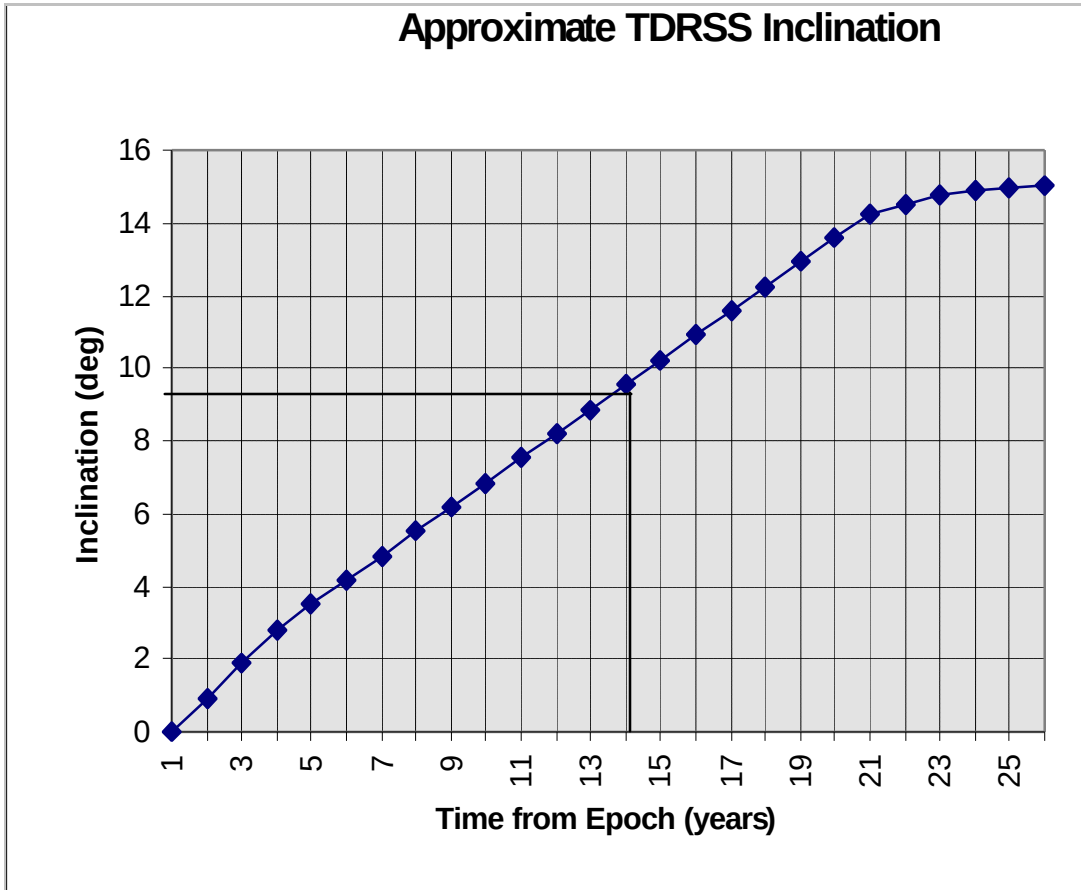
  The baseline data communications services (traditional Internet) provided by the other satellite systems (GOES, MARISAT, LES) will not have the capacity to fulfill this requirement. **Presently, no inclined commercial satellites provide this type of service into South Pole. NASA’s Tracking Data Relay Satellite System (TDRSS) network is capable of very high data rates and starting in 1996 the TDRSS F1 satellite will be sufficiently inclined to be visible from South Pole Station approximately 2 and a half hours per day.**

1997 South Pole Station Coverage

- TDRS-F1 fills the gap between LES-9 and GOES-3



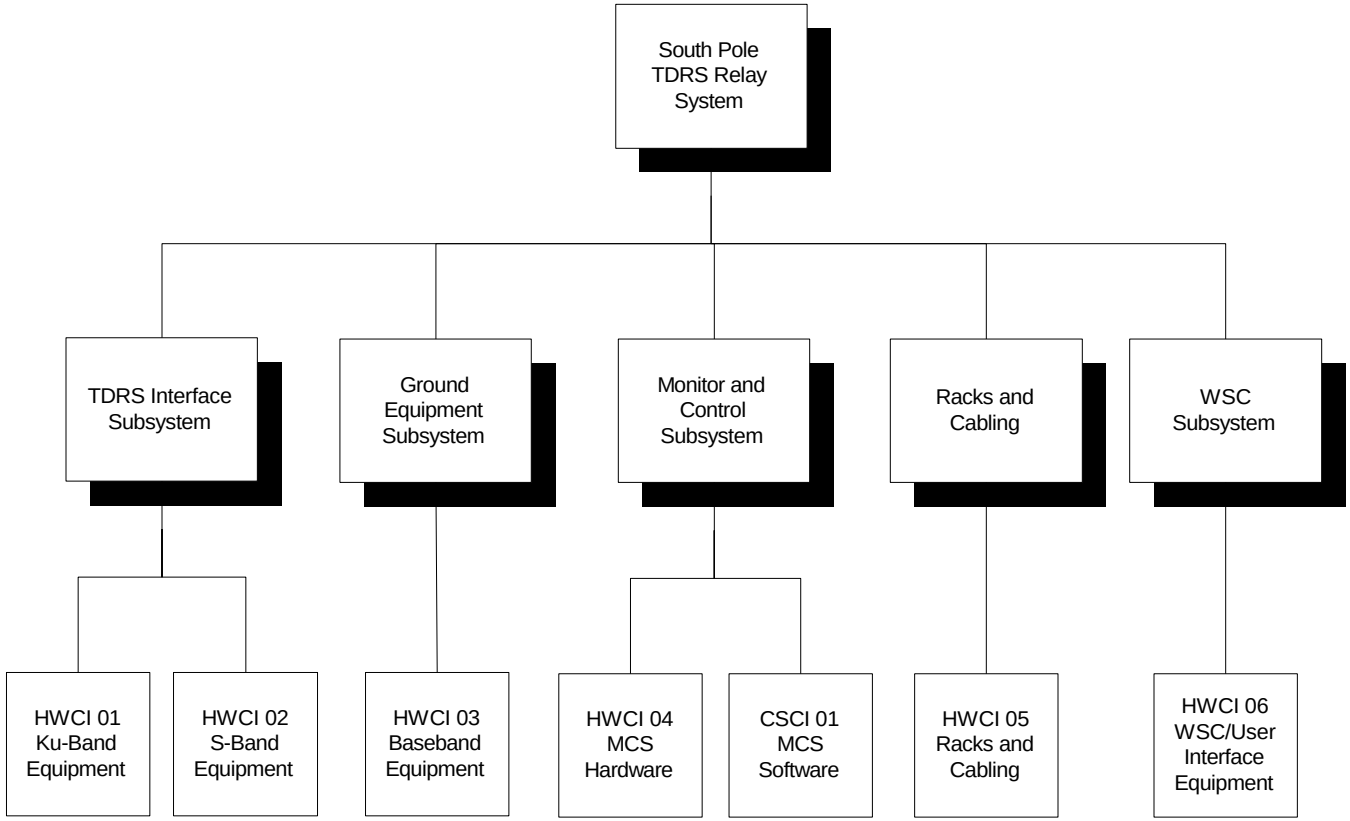
TDRS-F1 Inclination



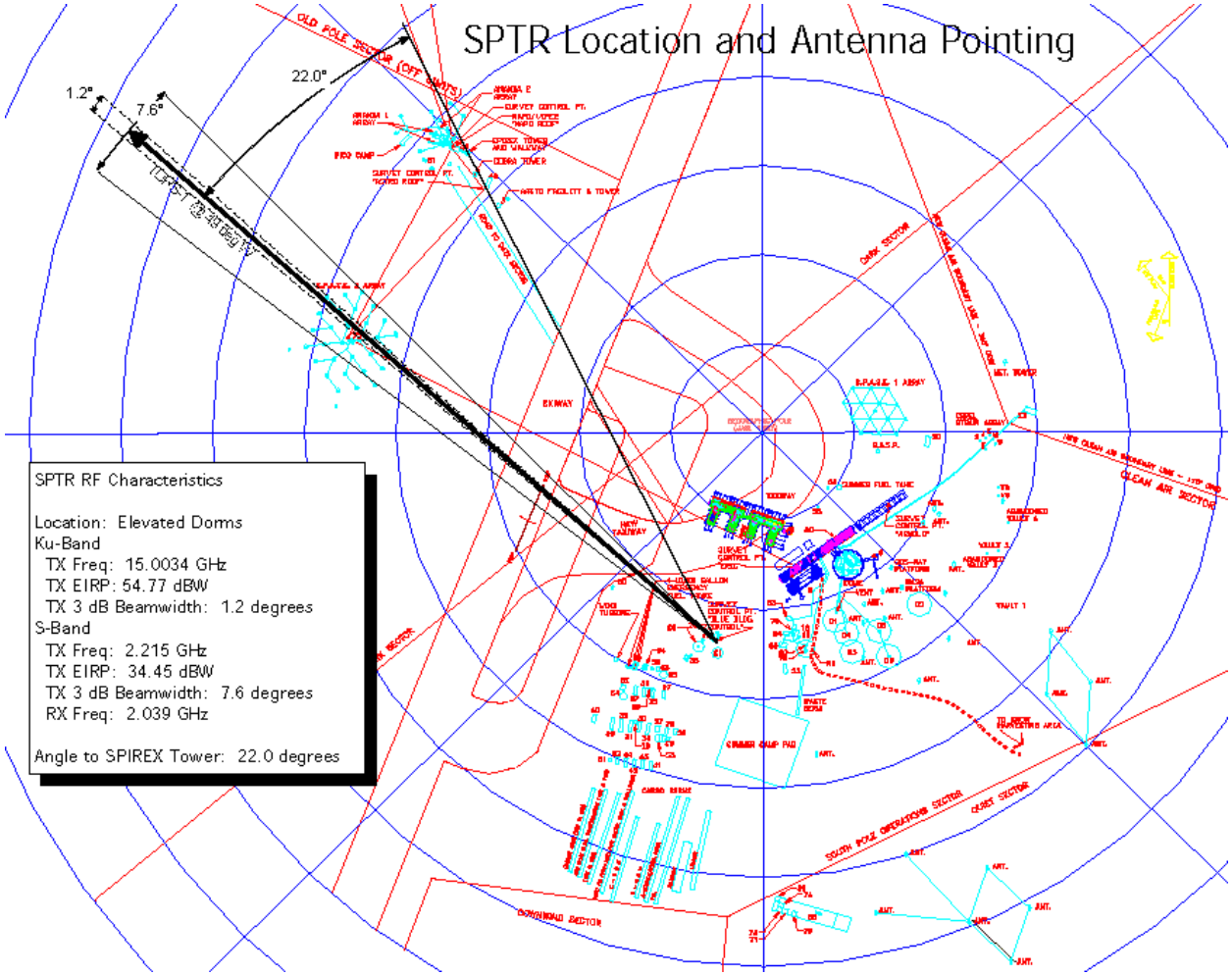
Tracking and Data Relay Satellites

Spacecraft	Launched	Geosynchronous Orbit	In-orbit Checkout Complete	Utilization	Cur Incl
TDRS-1	April 4, 1983 STS-6 (Challenger)	June 29, 1983	Dec 28, 1983	- Currently at 49° W - Stored spare	9.38
TDRS-2	Jan 28, 1986 STS-51L (Challenger)	na	na	- Lost	na
TDRS-3	Sept 29, 1988 STS-26 (Discovery)	Sep 30, 1988	Jan 15, 1989	- Currently at 275° W - Designated as TDRS-ZOE & support GRO	3.04
TDRS-4	March 13, 1989 STS-29 (Discovery)	March 14, 1989	June 9, 1989	- Available as backup - Currently designated as TDRS East at 41° W & providing user support	0.44
TDRS-5	Aug 2, 1991 STS-43 (Atlantis)	Aug 3, 1991	Oct 7, 1991	- Currently designated as TDRS West at 174° W & providing user support	0.02
TDRS-6	Jan 13, 1993 STS-54 (Endeavour)	Jan 14, 1993	March 4, 1993	- Currently at 46° W - Stored spare	0.06
TDRS-7	July 13, 1995 STS-70 (Discovery)	July 14, 1995	Aug 22, 1995	- Currently at 171° W - Stored spare	1.26

HWCI Structure

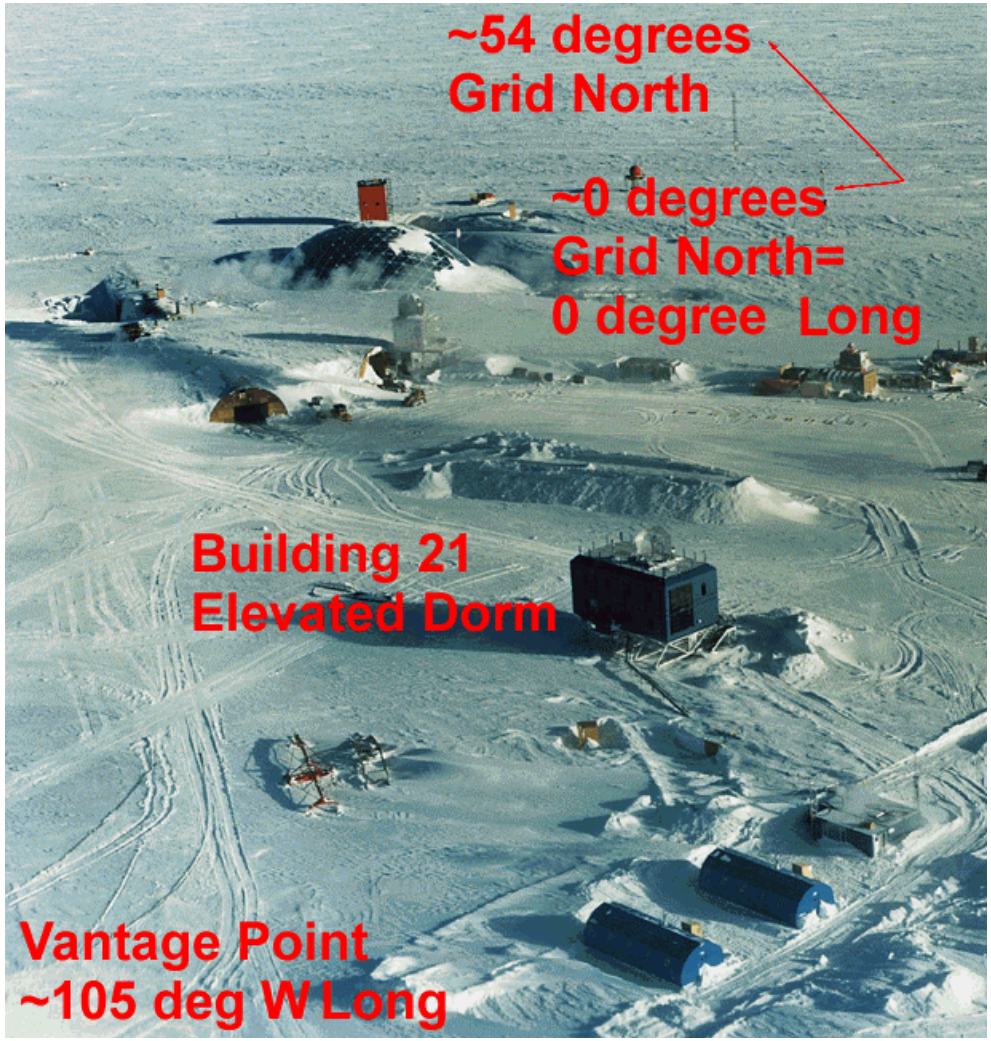


Site Map


SPTR Location and Antenna Pointing
1.2°
7.6°
22.0°
SPTR RF Characteristics
Location: Elevated Dorms
Ku-Band
TX Freq: 15.0034 GHz
TX EIRP: 54.77 dBW
TX 3 dB Beamwidth: 1.2 degrees
S-Band
TX Freq: 2.215 GHz
TX EIRP: 34.45 dBW
TX 3 dB Beamwidth: 7.6 degrees
RX Freq: 2.039 GHz
Angle to SPIREX Tower: 22.0 degrees

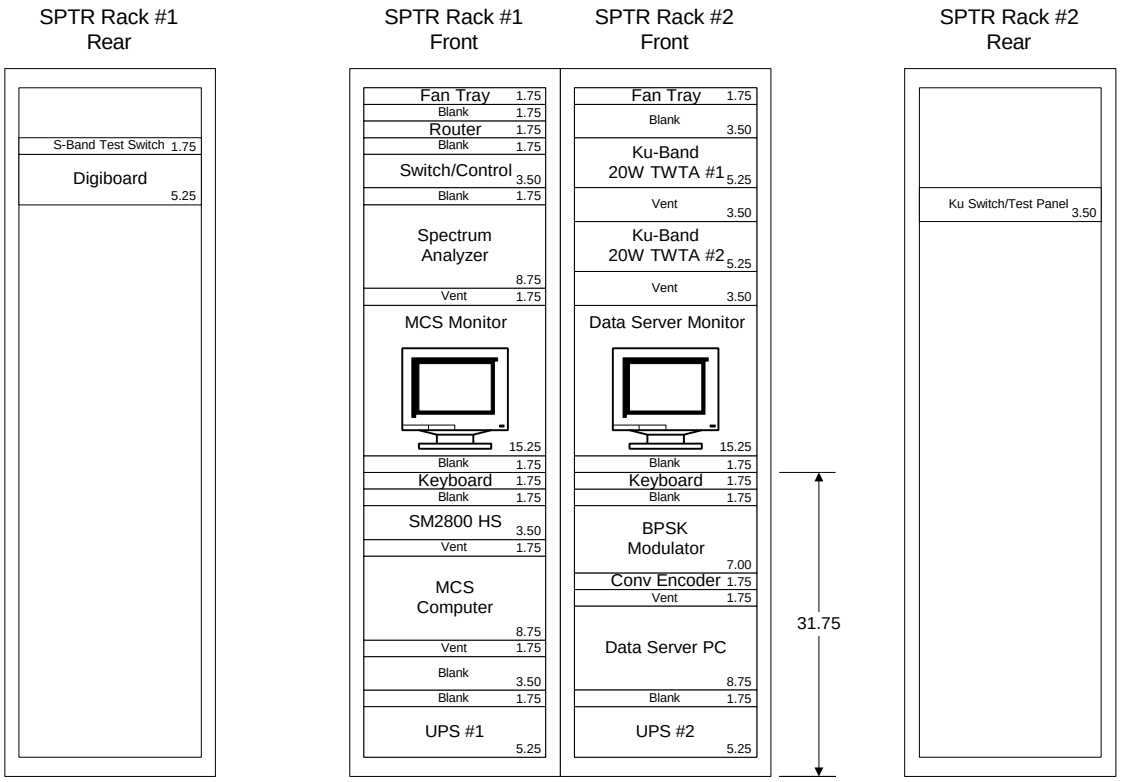
SPTR Location

- Co-located in Building 21 with the GOES system.
- Points to 49^{0}W over the SPASE II array.



South Pole TDRSS Relay (SPTR)

Rack Elevations



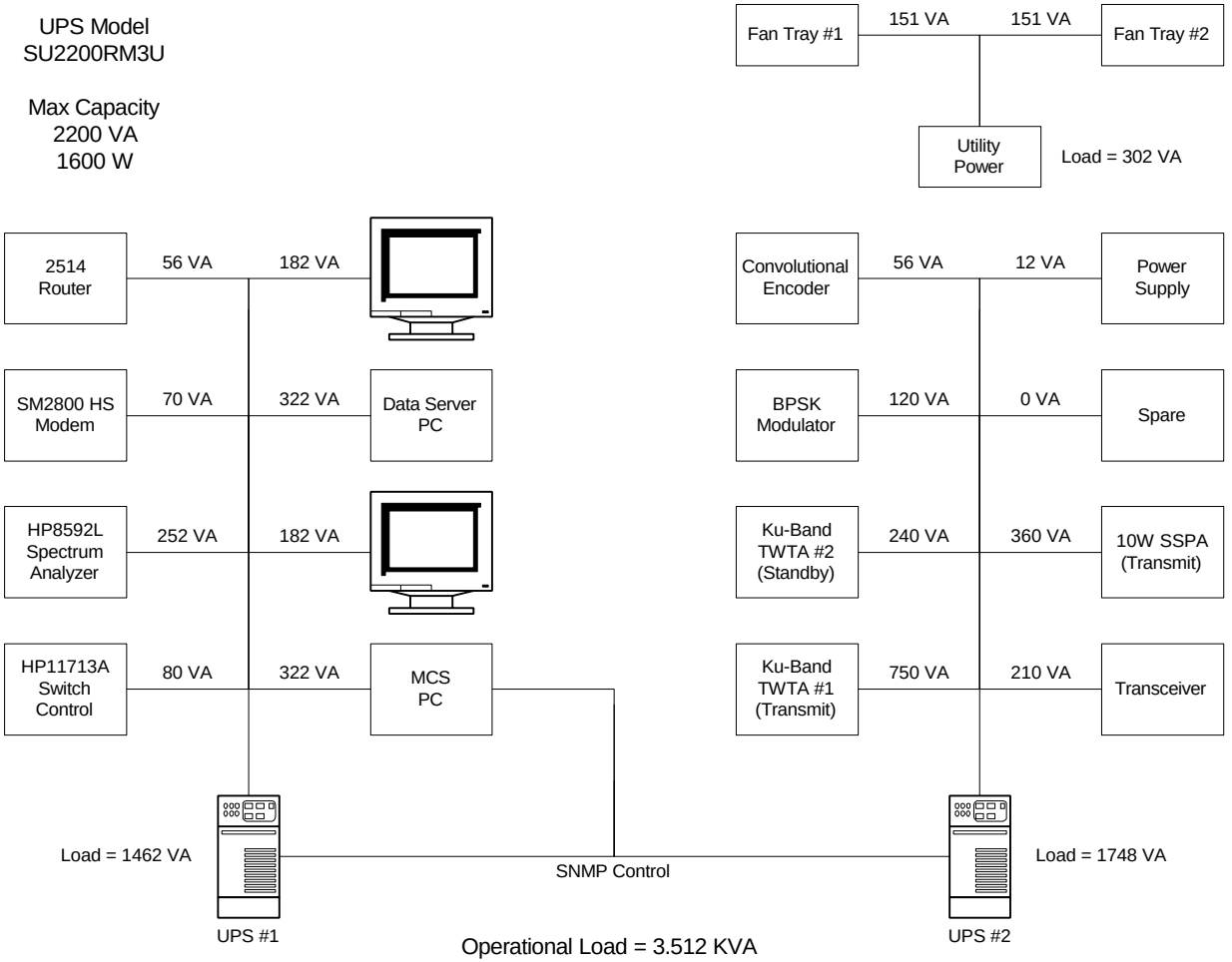
Notes:

1. Both racks will have top entry cabling and waveguide and utilize overhead cable trays and routing.
2. Panels designated Blank will be filled.
3. Panels designated Vent will be vented or open to direct air flow.
4. Keyboard height is ergonomic for console height.

Rack Dimensions:

Outside	Usable
W: 22"	19"
H: 74"	70"
D: 30"	28"

UPS Utilization (Max Loads)



Typical Load

UPS Port	Device	Voltage (VAC)	Amperes (A)	Operational Load VA	Operational Load W	Standby Load VA	Standby Load W
1	Switch Control	120	0.67	80	57	80	57
2	Spectrum Analyzer	120	2.10	252	180	252	180
3	Satellite Modem	120	0.58	70	50	70	50
4	Router	120	0.47	56	40	56	40
5	Server Monitor	120	1.50	180	129	180	129
6	Server PC	120	2.68	322	230	322	230
7	MCS Monitor	120	1.50	180	129	180	129
8	MCS PC	120	2.68	322	230	322	230
	UPS #1			**1462**	**1044**	**1462**	**1044**
1	TWTA #1	120	6.25	750	536	0	0
2	TWTA #2	120	2.00	240	171	0	0
3	Modulator	120	1.00	120	86	0	0
4	Encoder	120	0.47	56	40	0	0
5	Power Supply	120	0.10	12	9	0	0
6	Spare	120	0.00	0	0	0	0
7	10W SSPA	120	3.00	360	257	0	0
8	Transceiver	120	1.75	210	150	0	0
	UPS #2			**1748**	**1249**	**0**	**0**
	Fan Tray #1	120	1.26	151	108	151	108
	Fan Tray #2	120	1.26	151	108	151	108
	Utility Power			**302**	**216**	**302**	**216**
	Total Power	120	29.27	3512	2509	1764	1260
	Total Power (K)			**3.512**	**2.509**	**1.764**	**1.260**

Note: Power supply is used for the baseball switch and has 1A max instantaneous.

Proposed 1997 Mission to South Pole

- Ku-Band SA Return Link Proof-of-Concept
  - Test 50 Mbps data link using PN data
  - Test the data link using science data
  - Perform a bulk data dump from South Pole to GSFC
  - Gather engineering data on link performance and statistics

- S-Band SA Forward and Return Link Proof-of-Concept
  - Test link to 1.024 Mbps using PN data
  - Test interactive link
  - Leave equipment for interactive link
  - Gather engineering data on link performance and statistics