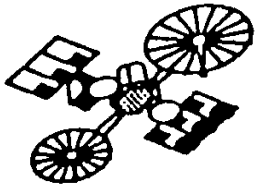
May 2, 1997

South Pole TDRS Relay



TDRS-F1
49W

Proposal

Scope

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.

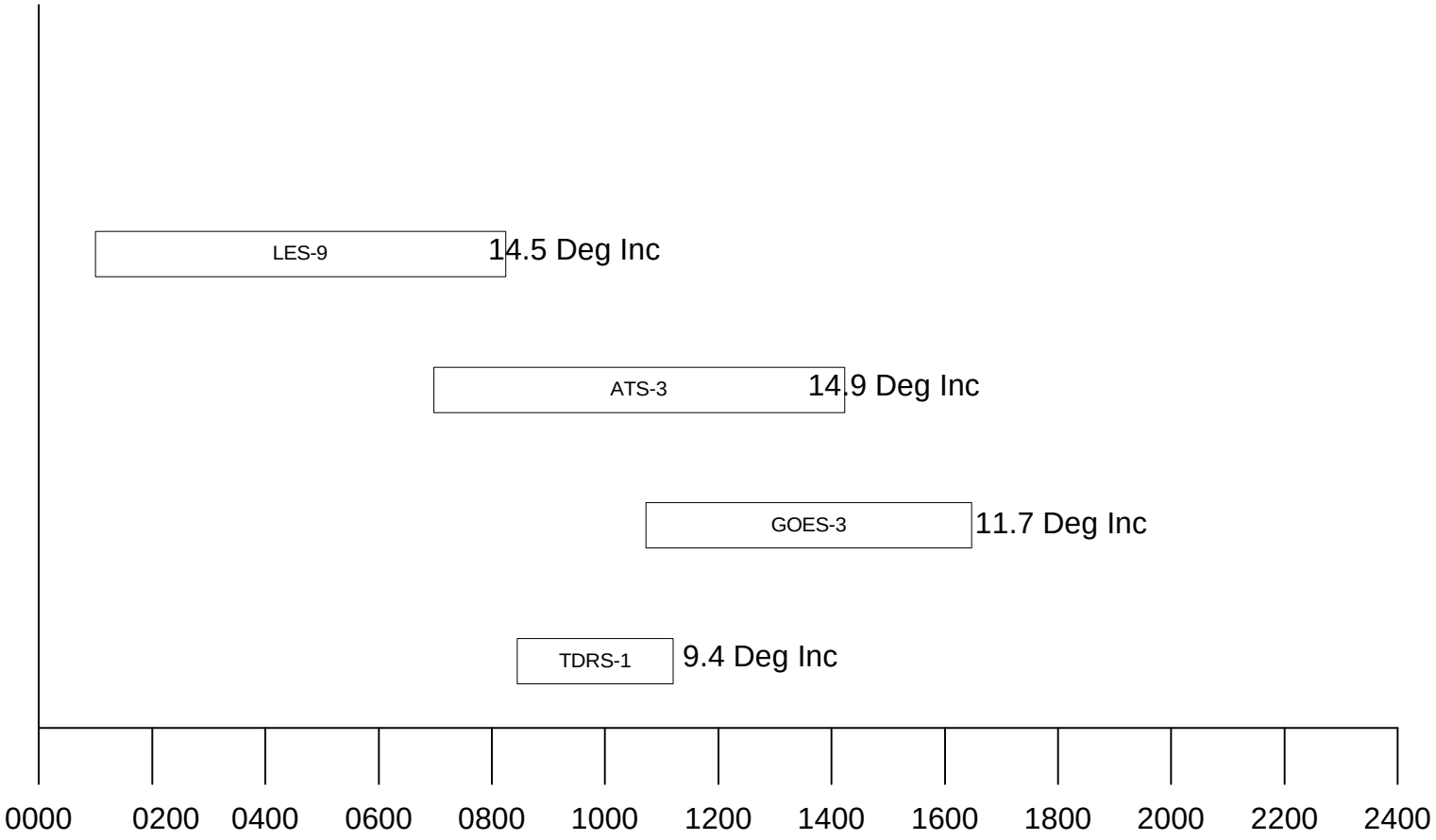
The baseline data communications services (traditional Internet) provided by the other satellite systems (GOES, MARISAT, LES) will not have the capacity to fulfill this requirement. **Presently, no inclined commercial satellites provide this type of service into South Pole. NASA’s Tracking Data Relay 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.**

Requirements

- Connectivity / Interactivity
  - CONUS researcher commanding South Pole based equipment
  - TCP/IP provides real-time interaction
- Time of connection
  - Use of TDRS F1 closes the gap between LES-9 and GOES-3
  - TDRS time increases as inclination grows
- Bandwidth and throughput
  - The AMANDA project has a growing need for bulk data (GBytes/day) to be transmitted
  - The SAO 10M Telescope will require even more bandwidth

South Pole Station Coverage

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

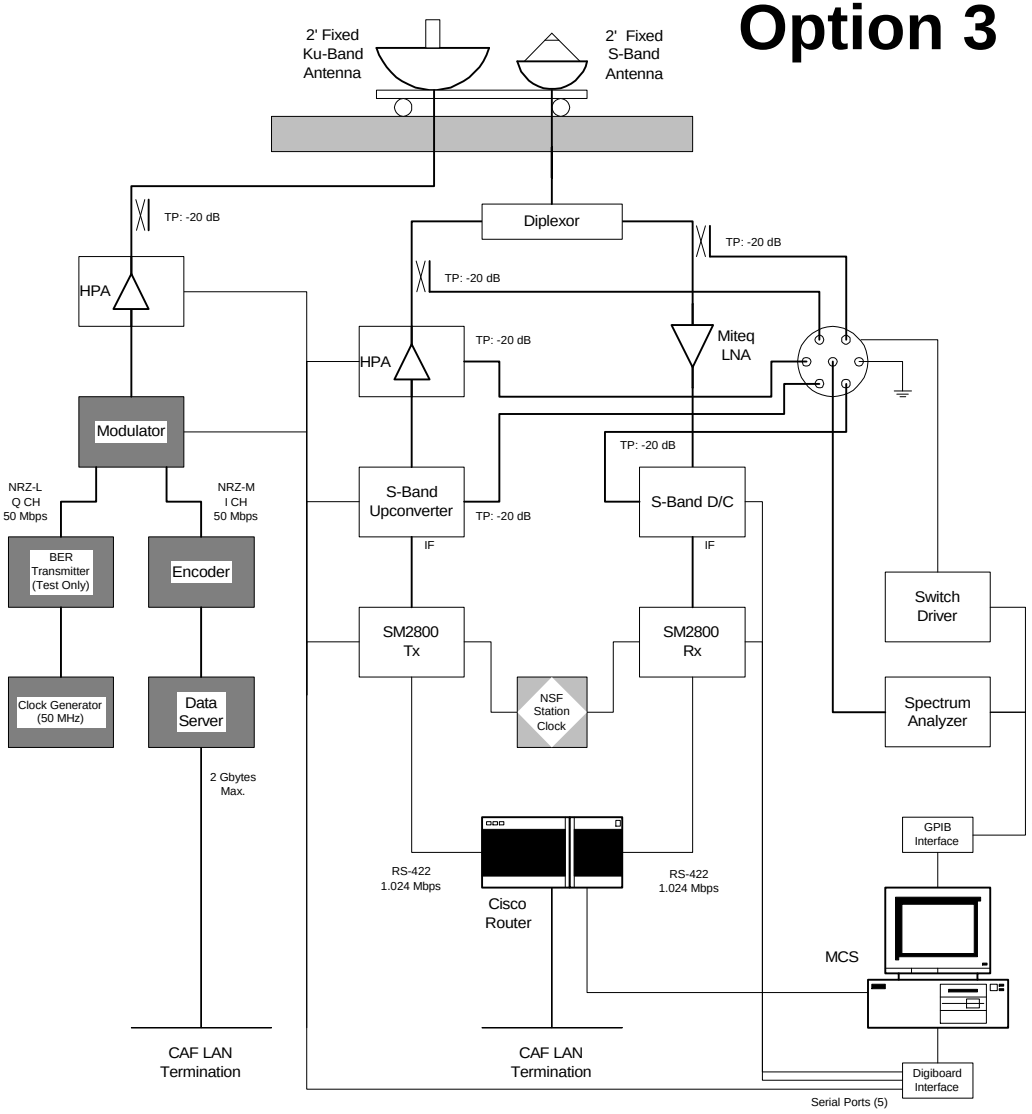


Design (Option 3)

- 2 ft Ku-Band antenna on fixed mount
  - KSA Return service via F1
  - 50 Mbps rate for testing the bulk data dump
  - Potentially install a 2-10 Mbps service for winter-over operations
- 2 ft S-Band antenna on fixed mount
  - SSA Forward and Return service via F1
  - 1.024 Mbps rate full duplex TCP/IP connection
- S-Band connection to South Pole LAN similar to existing GOES-3 link
  - Maximize COTS equipment
  - Duplicate South Pole proven equipment where possible
- No redundancy, single string capability

South Pole TDRS Relay (SPTR)

Option 3



- Specifications
  - SSAF Rate = 1.024 Mbps (2.048 Msps)
  - SSAR Rate = 1.024 Mbps (2.048 Msps)
  - KSAR Rate = 50 Mbps Demo
    10 Mbps Dump
    (20 Msps)
- Pros
  - Provides connectivity with 1.024 Mbps S-Band TCP/IP link
  - TCP/IP SSA service available for winter-over operations
  - Capability of up to 50 Mbps data transfer
  - Short procurement times
- Cons
  - 2 Gbyte data buffer required at WSC
  - Data management protocol required for data dumps

Proposed 1997 Mission to South Pole

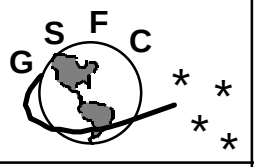
- Ku-Band SA Return Link
  - Test 50 Mbps data link using PN data
  - Test the data link using science data
  - Perform a bulk data dump from South Pole to GSFC
  - Gather engineering data on link performance and statistics
- S-Band SA Forward and Return Link
  - Test link to 1.024 Mbps using PN data
  - Test interactive link
  - Leave equipment for interactive link
  - Gather engineering data on link performance and statistics
- S-Band MA Link (Proof-of-Concept)
  - Borrow 9.6 kbps duplex PORTCOMM
  - Connect to AGO (TBD)

Issues

- Life / longevity of TDRS F1
  - Future replacements
- S-Band frequency selection and clearance
- Maximum data rates for S-Band Forward
- Single string of equipment, no redundancy
- Funding
- Rapidly approaching deadlines
  - Procurement must start immediately
  - Need to ship by August
- NASCOM connectivity/security
- South Pole data server/data management dump protocol
- TCP/IP latency via geo-sync satellite link
  - Under investigation

Summary/Recommendations

- Each of the options provides an interactive TCP/IP interface
- Options 1 & 2 do not provide a high rate data dump
- Option 3 is the recommended approach
  - Separation of the connectivity and the high speed dump functions
  - TCP/IP interface on SSAR and SSAF
    - » Simplifies the satellite modem and router functions
    - » Reduces the overall cost
  - Can be done in increments to spread costs over several fiscal years



Backup Material

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

TDRS-1 Inclination