THE ACTS PROPAGATION PROGRAM

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Introduction

The purpose of the Advanced Communications Technology Satellite (ACTS) is to demonstrate the feasibility of the Ka-band (20 and 30 GHz) spectrum for satellite communications, as well as to help maintain U.S. leadership in satellite communications. ACTS incorporates such innovative schemes as time division multiple access (TDMA), microwave and baseband switching, onboard regeneration, and adaptive application of coding during rain-fade conditions.

The success or failure of the ACTS experiment will depend on how accurately the rain-fade statistics and fade dynamics can be predicted in order to derive an appropriate algorithm that will combat weather vagaries, specifically for links with small terminals, such as very small aperture terminals (VSATs) where the power margin is a premium.

This article describes the planning process and hardware development program that will comply with the recommendations of the ACTS propagation study groups.

ACTS Propagation Terminal Development Plan

A plan for the ACTS propagation terminal was initiated at the first ACTS Propagation Studies Workshop, November 28-29, 1989. The workshop's goal was to develop the ACTS Propagation Studies Program. During this workshop, participants delivered a set of recommendations regarding propagation studies and experiments that would use ACTS. In their recommendations, the group addressed a number of topics, including the need for propagation data and the configuration and number of propagation terminals needed.

The participants also provided guidelines regarding measurement parameters and requirements. These guidelines specify how the terminal should be configured so that it can record the following propagation and meteorological parameters:

- 20-GHz beacon receive signal level
- 27-GHz beacon receive signal level
- 20-GHz radiometric sky noise temperature
- 27-GHz radiometric sky noise temperature
- Point rain rate near the terminal

- Atmospheric temperature at the Earth's surface
- Atmospheric humidity at the Earth's surface

In response to the recommendations concerning propagation terminals, a two-phase plan has been devised. In phase 1, a terminal prototype is being developed, and in phase 2, six to eight terminals will be manufactured for distribution to ACTS propagation experimenters.

Prototype Receive Terminal Development

A NASA research grant was awarded to Virginia Polytechnic Institute in early 1991 for the Prototype development. The Prototype ACTS propagation receiver terminal will consist of a common antenna, a dual-channel digital receiver, a dual-channel analog radiometer, and a data acquisition system. The terminal will also be equipped with meteorological recorders for measuring the point rain rate and the atmospheric temperature and humidity.

A simplified block diagram of the receiver terminal is shown in Fig. 1. The salient features of the terminal are as follows:

- 1.2-m common antenna
- Ortho-Mode Transducer (OMT) to split 20-GHz V- and H-Pol (if used)
- 20-/30-GHz diplexer to split 20- and 30- GHz V-Pol signal
- Cost-effective low-noise amplifiers followed by single downconversion to 70-MHz intermediate frequency (IF)
- Total power radiometer with detectable sensitivity of ± 1 K
- Data collection - PC/AT-based

The design will be based upon modular form for easier integration and testing.

Worst-case ACTS link budget is shown in Table 1.

Table 1. ACTS Link Calculations

Beacon frequency band (GHz)	27.5	20
Common antenna size (m)	1.2	1.2
Antenna gain (dB)	49	46.4
Nominal CONUS EIRP (dBW)	16	16
Transmission loss (dB)	2.0	1.8
Modulation loss (dB)	-	3.2
Path loss at 30-deg elevation (dB)	215	212
Total loss (dB)	217	217
Low-noise-amplifier noise figure (dB)	7	7
Receive G/T (dB/K)	17.6	15.1
Carrier-to-noise density (C/N), (dB-Hz)	45.2	42.7
C/N over 15 Hz (dB)	33.4	30.9

The above table shows the worst-case C/N within the CONUS coverage. For an experimental site in Alaska, the reduced EIRP as seen from Alaska can be compensated by a 2-m antenna.

Schedule

The tentative schedule summary for ACTS Propagation Studies is shown below:

Completion of Prototype Terminal	Feb. '92
Selection of Experimenters	Aug. '92
Completion of 6-8 Terminals Production	Oct. '92
Installation and Calibration of Terminals	Dec. '92
ACTS Launch	Late '92
Start of Data Collection	Early '93

Data Collection Sites

Rain climate zones without prior propagation data will receive special consideration. Sites with an ongoing environmental sensing program employing radiosondes, weather radars, etc., will be given higher priority.

Additional ACTS-Related Tasks

In addition to the planning discussed above, the following tasks need to be completed:

- Plan propagation study pertinent to mobile environment
- Plan fade detection and compensation via uplink power control
- Support ACTS Conference in August '91 and organize ACTS Workshop in late 1991 or early 1992
- Possibly organize a 20-/30-GHz Technology Workshop in GLOBCOM '92
- Select a central processing site for ACTS data reduction and analysis

Conclusions

The ACTS Propagation Study Planning and developmental efforts are highlighted. No major constraint is foreseen at this time.

FUNCTIONAL BLOCK DIAGRAM OF THE ACTS TERMINAL