Insert Number 5
March, 1992

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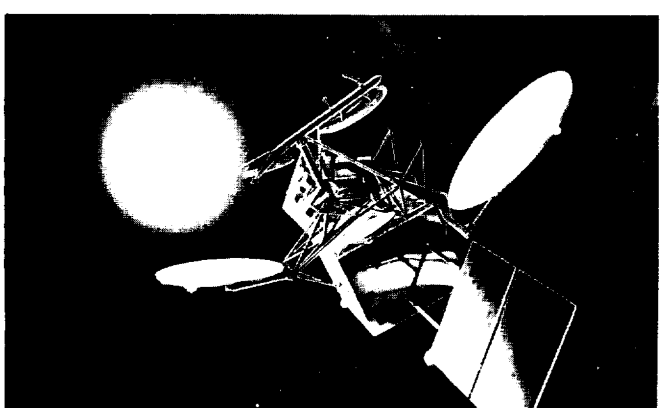
ACTS

Systems Overview

The Advanced Communications Technology Satellite (ACTS), sponsored by the National Aeronautics and Space Administration (NASA), is an experimental satellite operating in the Ka frequency band (30 and 20 GHz) and scheduled for launch in the first quarter of 1993. ACTS is a key element in NASA's program of developing high-risk, advanced communications technology that is usable in multiple frequency bands to support our Nation's future communications needs. Realizing this goal will enable growth in capacity, effective use of the frequency spectrum, and more cost-effective delivery of existing services and will maintain the United States preeminence in satellite communications.

The technologies of ACTS, which include multiple dynamically hopping spot beams and advanced onboard switching and processing, will open new vistas in communications satellite technology. They will also allow the use of very small-aperture Earth terminals (VSAT's) with advanced capabilities. Among the ACTS efficiencies are wide geographical area coverage, demand-assignment access, full-mesh interconnectivity, and service flexibility by integrating voice, data, and video operations at throughput rates of 1.544 Mbps (T1) using 1.2-m VSAT Earth terminals.

The ACTS flight and ground systems will be made available to the private and public sectors (corporations, universities, and government agencies) for demonstration and evaluation of the technology applications after launch.



Key ACTS Technical Component Suppliers

General Electric Astro-Space	System design; spacecraft development
Comsat	Network architecture; master control station; NASA ground station; integrated services digital network (ISDN); network operations
Motorola Inc.	Baseband processor; ground modems
Harris Corp.	T1 VSAT Earth terminal
Orbital Sciences; Martin Marietta	Transfer orbit stage (perigee stage)
Electromagnetic Sciences, Inc.	Beam-forming network
Watkins-Johnson	Flight traveling wave tubes
Composite Optics	Spacecraft bus; spacecraft antennas and subreflectors
FEIM	Spacecraft 30-GHz wideband adapter amplifiers
General Electric Syracuse	30-GHz high-electron-mobility transistor (HEMT)
TIW	NASA ground station 5.5-m antenna
Prodelin	T1 VSAT Earth terminal antenna
MA/COM	High-power frequency doubler
NASA Lewis Research Center	Link evaluation terminal (LET)
Jet Propulsion Laboratory (JPL)	Mobile terminal
NASA Lewis/JPL	Aeronautical terminal
Texas Instruments; Boeing; General Electric	Aeronautical phased-array antennas (20 GHz and 30 GHz)
Virginia Polytechnic Institute	Propagation terminal

(NASA-TM-107800) ACTS SYSTEMS OVERVIEW (NASA) 4 p

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Key ACTS Technology

High-EIRP, fast-hopping spot beams

Spectral reuse through spatial diversity
Higher throughput VSAT s (T1 rate)
Smaller Earth terminals
Efficient capacity assignment to geographically nonuniform demand

Onboard processing

Switching and routing on board at individual voice circuit level
Single-hop mesh voice network
Improved signal to noise ratio

Ka band

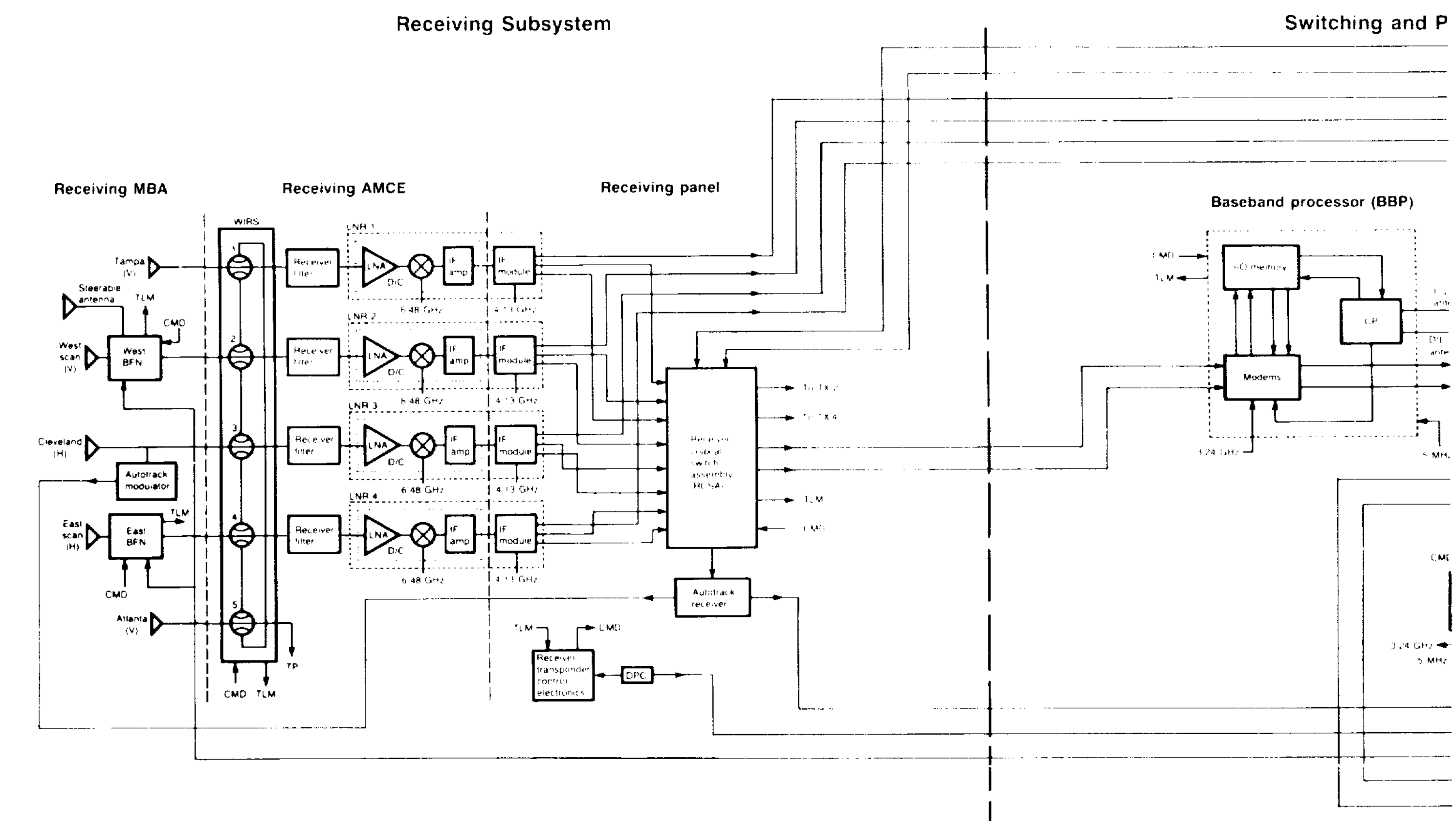
Opening a new band
2.5-GHz bandwidth
Dynamic rain fade compensation

Specifications

Type	Three axis stabilized communications technology satellite
Application	Testbed of new technology applications, available to U.S. experimenters free of charge
Launch vehicle	Space Transportation System/transfer orbit stage (TOS)
Orbit position	Geosynchronous, equatorial, 100° West
Design life	2 years; 4 years of stationkeeping fuel

Communications Payload

Frequency	Four Ka-band (30/20 GHz) transponders
Bandwidth	800 MHz each channel, 2.4 GHz total
Radiofrequency power	46 W/channel
Redundancy	One standby channel (4 for 3 redundancy)
Coverage	Two contiguous sectors in Northeastern United States plus 16 isolated spot beams covering selected U.S. locations, also full visible Earth coverage via mechanically steerable spot beam
Receiver antennas	2.2 m dish and 1.1-m steerable
Transmitter antennas	3.3 m dish and 1.1-m steerable
Effective isotropic radiated power	Isolated spot beams, 60 dBW; contiguous sectors, 59 dBW; steerable beams, 53 dBW
Receiver noise figure	3.4 dB (HEMT front end)
Onboard switching	Baseband processor provides demodulation, storage, and remodulation of data; two 110-Mbps time-division multiple access/demand assignment multiple access (TDMA/DAMA) data streams assignable in increments of 64 kilobits; high-speed programmable 3×3 switch matrix provides three input and three output microwave switch matrix (MSM) channels with 900-MHz bandwidth
Fade beacons	Stable signals radiated from satellite in the uplink (30 GHz) and downlink (20 GHz) frequency bands to permit link fade measurements



Fade compensation, BBP mode	Combination of convolutional coding, data rate reduction, and transmitter margin; 15-dB design margin on uplink and 6-dB margin on downlink
Fade compensation, MSM mode	Power control on uplink as indicated by monitoring fade beacon at uplink frequency; 16-dB design margin on uplink and 8-dB margin on downlink

Electrical Power Distribution

Solar array output	1418 W (4 years)
Battery system	2 NiCd batteries of 19 AH each; no payload operation during eclipse
Power bus	35.5 (±0.5) V with full array illumination

Propulsion and Orbit Control

Design	Blowdown hydrazine system with redundant thrusters and four tanks
Propellant	550 lbm
Thrusters	16 (0.2, 0.5, and 1.0 lbf)
Stationkeeping	±0.05°

Structure and Thermal

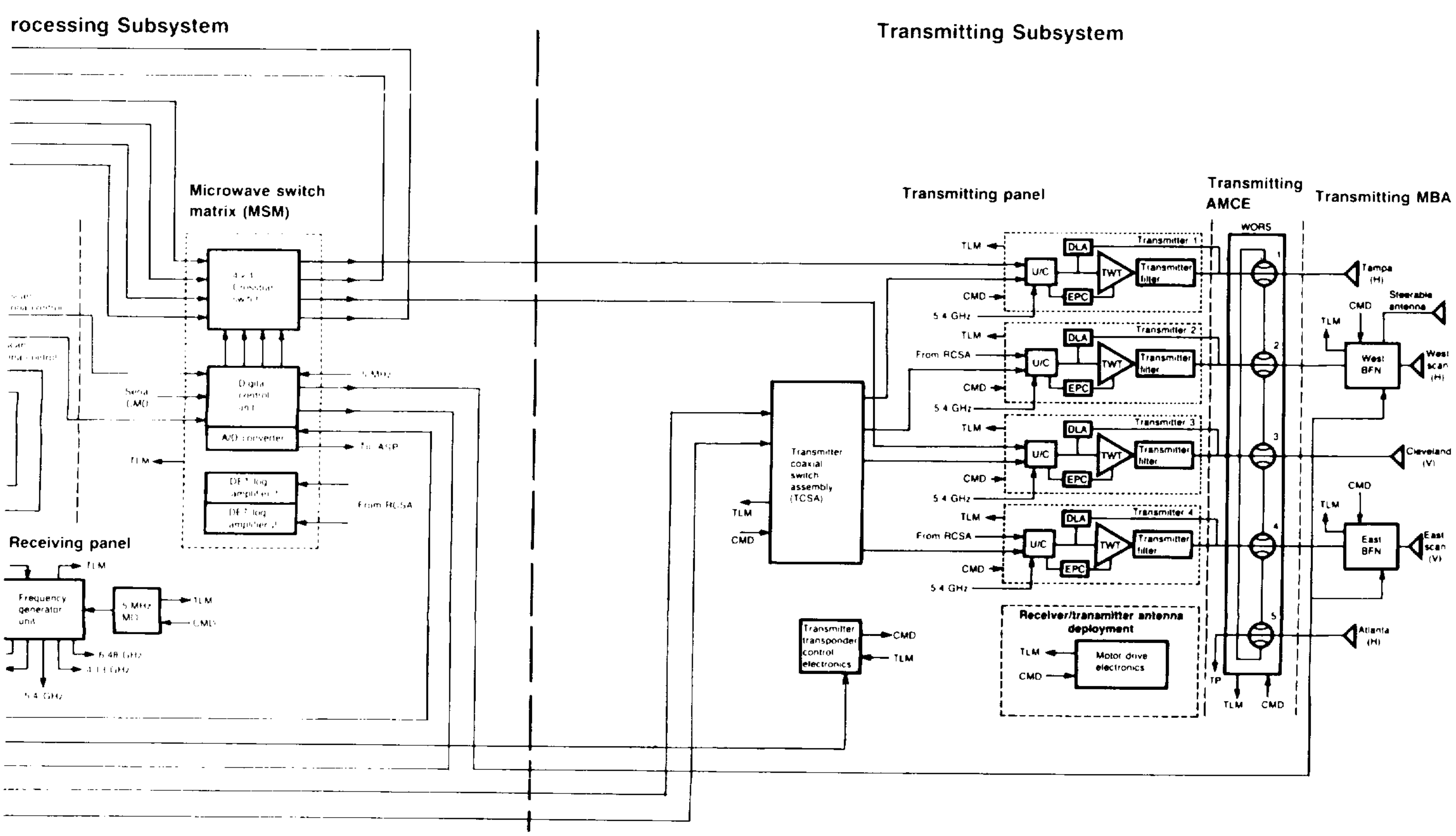
Structure	Length, 80 in.; width, 84 in.; depth, 75 in.
Solar array	With yoke, 46.9 ft tip to tip
Antenna assembly	Height, 116 in. above antenna panel; width, 29.9 ft deployed
Thermal control	Passive temperature control, blankets and optical solar reflector; active temperature control, solid-state controllers and heaters

Attitude Control

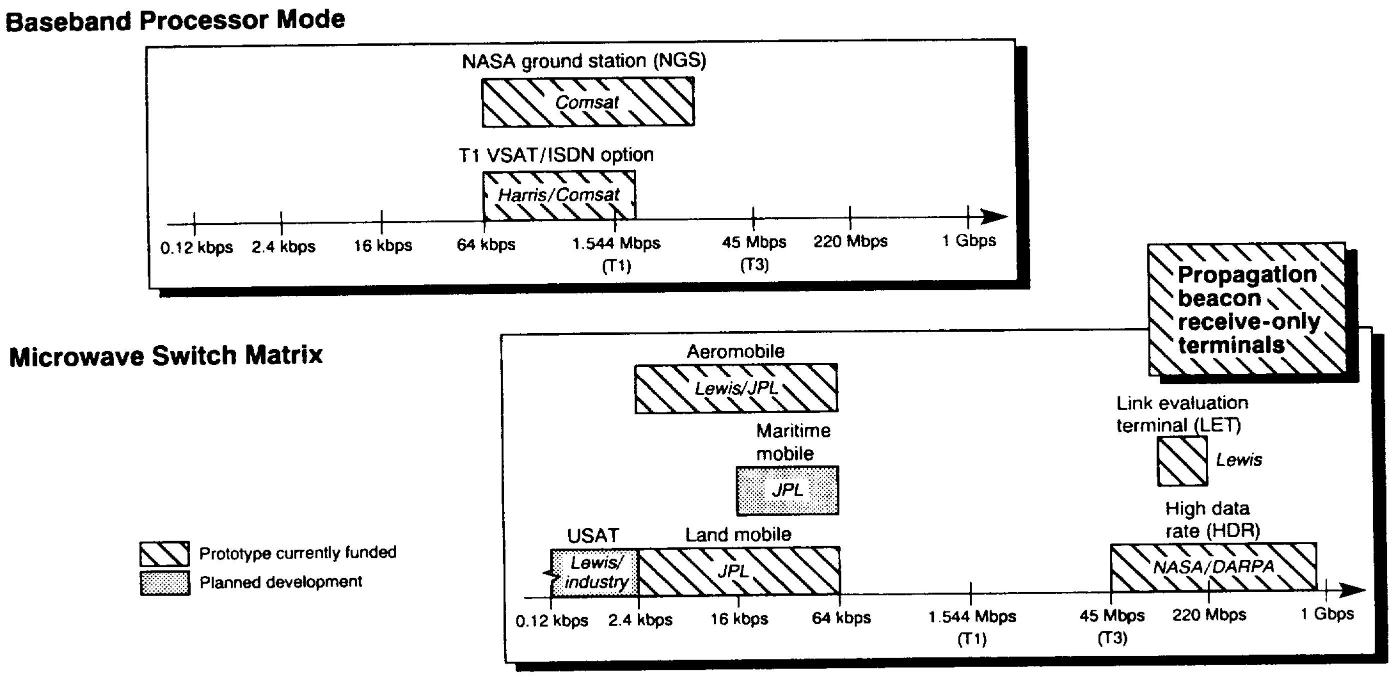
Transfer orbit control	Autonomous nutation control during spin; initial pointing provided by TOS
On-orbit control	Three-axis-stabilized via Earth and Sun sensor and momentum wheel; autotrack reference used during communications experiment periods
Pointing accuracy	0.025° pitch and roll and 0.15° yaw using autotrack; 0.1° pitch and roll and 0.25° yaw using Earth sensor
Offset pointing control	±6° pitch, ±2° roll

Command, Ranging, and Telemetry

Command frequency	Ka band; C-band backup and transfer orbit
Command rate	100-pps frequency shift keying for bus functions; 5000-pps space-to-ground link system for payload
Command capacity	379 Low-rate discretes, 3 serial low-rate data streams; 256 high-rate discretes; 3 serial high-rate data streams
Telemetry frequency	Ka band; C-band backup and transfer orbit
Telemetry format	8 bits/word; 256 words/minor frame, 25 minor frames/major frame; 1024 bps
Telemetry capacity	312 Bilevel words; 364 analog words, 6 serial words; dwell capability on any analog, bilevel, or serial word
Tracking frequency	Ka band; C-band backup and transfer orbit
Tracking tones	Four from 35.4 Hz to 27.777 kHz



ACTS Experimenter Terminal Types



Potential high-payoff application areas using ACTS technology

- T1 VSAT (1.544 Mbps) full-mesh network
  —Data, voice, and video
  —ISDN
- High data rate (≥300 Mbps)
- Mobile
  —Aeronautical
  —Land
  —Maritime
- Ultra-small-aperture (USAT)—supervisory control and data acquisition (SCADA) (kbps)

ACTS will use two types of onboard switching to interconnect the multiple spot beams and to route signals to their appropriate destinations. The baseband processor mode will use onboard memory and circuit switching to efficiently route low-volume communications traffic from small 1.2-m Earth terminals. The microwave switch matrix mode, a memoryless matrix switch, will provide dynamic beam-to-beam routing by using a 3 × 3 configuration and 800-MHz-bandwidth channels.

In each mode of operation the various Earth terminals under development will permit a wide variety of communications applications to be tested. The 1.2-m and 2.4-m VSAT's in the baseband processor mode will provide capability for integrated voice, video, data, and ISDN traffic to be delivered to multiple destinations in a single hop with throughputs up to 1.79 Mbps per Earth terminal. The microwave switch matrix mode will accommodate Earth terminals operating in the low kilobits per second for various mobile and USAT-SCADA types of applications to hundreds of megabits per second for high-data-rate applications related to supercomputer interconnections, high-definition television, and hybrid fiber optic/satellite links. In addition, receive-only propagation Earth terminals will be used to collect data from the ACTS 20-GHz and 30-GHz beacons.

The NASA ACTS satellite will provide an on-orbit testbed for those high-risk technologies that have the potential to dramatically enhance the capabilities and reduce the user service costs of the satellite communications industry. ACTS—the switchboard in the sky—will serve as the technology "blueprint" for future communications satellites.

For further information contact

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