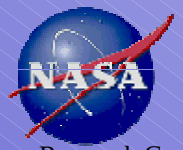

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Advanced Communications Technology Satellite (ACTS) Extension Workshop

October 24, 2000

Ohio Aerospace Institute Auditorium

Glenn Research Center

Agenda

9:30	**Welcome and Introduction**	**Donald Campbell,** Director, NASA GRC
9:45	**The Opportunity and NASA offer**	**Robert Bauer,** ACTS Project Manager, NASA GRC
10:15	**The Consortium Approach**	**Joanne Poe,** GRC Consortium Consultant, Flowen
10:45	**Break**	
11:00	**Technical Briefing, Part 1**	
	ACTS System	**Richard Krawczyk,** **ACTS Operations Manager, NASA GRC**
	NASA Ground Station	**Steven Struharik,** **NGS Manager, LMGT**
12:00	**Lunch**	Sun Room, OAI

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Agenda

1:00 Technical briefing, Part 2	
Ground Station Capability	**Richard Reinhart,** **USAT and LET Manager, NASA GRC**
Multibeam Antenna	**Roberto Acosta,** **Senior Researcher, NASA GRC**
2:00 Break-out Meeting(s)	
- Interest and Membership Meeting	**Auditorium,** OAI
3:00 Break	
4:15 Tour of NASA Ground Station Facility	NASA GRC, Building 55
5:00 Adjourn	

Opportunity and NASA offer

Robert Bauer
NASA Glenn Research Center
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Overview of the ACTS

- Original program goals:
  - develop high-risk, high cost technology for next generation satellite systems
  - enable growth in capacity and utilization of frequency spectrum
  - maintain US pre-eminence in communications satellite technology
- NASA led experiments program December 6, 1993 - May 31, 2000
- ACTS is now permanently stationed at a geostationary (GEO) orbital gravity well at 105.2°W
- Opportunity for use by educational consortium for 2-4 years

Launched September 12, 1993 aboard STS 51 - Discovery

Overview of the Opportunity

ACTS Consortium for University Education

- NASA Glenn Research Center is offering the remaining life of the Advanced Communication Technology Satellite (ACTS) to a university consortium
- The mission of the consortium will be to maximize the use of a unique national asset to benefit space communications education, research and outreach

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Overview of the Opportunity

COMMERCE BUSINESS DAILY - Sources Sought

[Posted in CBDNet on October 4, 2000]

ACTS EXTENDED MISSION

The National Aeronautics and Space Administration (NASA) announces willingness to extend operations of the Advanced Communications Technology Satellite (ACTS) for education and research purposes to an education-based consortium. The spacecraft is permanently retired on-orbit at 105.2 degrees West longitude, but further use of its payload is feasible. The consortium is expected to fully fund the operations. A workshop will be held on October 24, 2000 at the Glenn Research Center, Cleveland, Ohio to present the opportunity.

Point of contact: Mr. Robert Bauer tel: 216/433-3431

Email robert.bauer@grc.nasa.gov

Overview of the Opportunity

ACTS FACTS

- $499 M spacecraft and ground segment development
  - Total program approximately $550M
- Original 4 year design life now in its 7th year of operations
  - All major subsystems operating without failure
- NASA-coordinated experiments concluded 5/31/00
  - 103 experiments involving 61 unique Principal Investigators
  - Over 100 other participating organizations

Satellite Focused Areas

- Assume ACTS spacecraft and control station operations
- Analyze spacecraft bus performance- thermal, electrical characterization/modeling
- Improvise new software for operations - laptop based?
- Automate operations
- Orbital modeling
- Attitude control
- Conjunction assessment
- Earth station design and tradeoffs
- Link margin calculations
- Fade mitigation techniques

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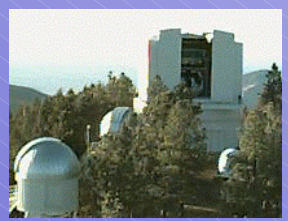
Applications Areas

- Telemedicine
- Distance Education
- Emergency Response
- Telescience
- Aeronautical/Maritime/Mobile
- Videoconferencing
- High Speed Networking
- Hybrid-satellite Links (Ku & Ka)
- Protocol evaluation/improvements over long latency links






NASA Contributions

- Access to ACTS with two to four years of potential operations
- Ground stations
  - Access to control station at GRC
  - Access to 1 hub experimenter terminal at GRC (LET)
  - 4 transportable experimenter terminals (USATs)
- Up to $10k per month to maintain the control station while ACTS is operative
- “Bridge funding” to continue operations of ACTS while the Consortium is being formed (≤ 6 mos.). During this time, GRC will seek alternative funding sources
- Licensing of spacecraft and NASA provided earth stations
- Hardware and software for spacecraft operations
- Engineering support during transition and ad hoc consultation after consortium in place

Universities/Consortium Contribution

- Ensure consortium is academia-based whose primary purpose is education & research
- Consortium formed by January 2001
- Consortium & NASA share operation costs from January 01-April 01
- Assume all operations and associated costs no later than April 2001
- Consortium open to national participation
- Consortium handles scheduling of spacecraft resources
- Consortium supports transportable ground segment usage including moves and maintenance of USATs

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NASA GRC's Minimum Requirements

- Potential members commit soon to form an ACTS Education Consortium and demonstrate diligence in its formation
- GRC retains right to partial use of transponder for experiments
- Participation by GRC on the board or committee governing the consortium
- Recognition by potential consortium members that there is no guarantee of ACTS functionality or quality of service

Overview of Consortium Approach

- Phased approach
  - **Phase 1(~ 6 months):**
    - Parties identify interest to NASA
    - Develop details of forming consortium
    - Seek consortium funding sources - (State, other Govt. agencies, industry,...)
    - Transition operations from NASA to consortium
  - **Phase 2:** Full consortium
    - Assume full operations
    - NASA participates as a charter member
- NASA is not developing the consortium
  - It is to be self-coordinated
  - NASA will work with interested parties

Operations Costs

- Spacecraft operations estimated at $60k per month
- Cost estimate developed based on NASA's experience with its current contractors and assumptions on level of support needed
  - Continue with current contractors
  - 8 hrs/day, 5 days/week with minimal staffing
  - On-call, or remote ops during other hours
  - May need extra support during eclipse seasons
- Does not include payload usage activities, consortium overhead & administration, earth station maintenance and moves

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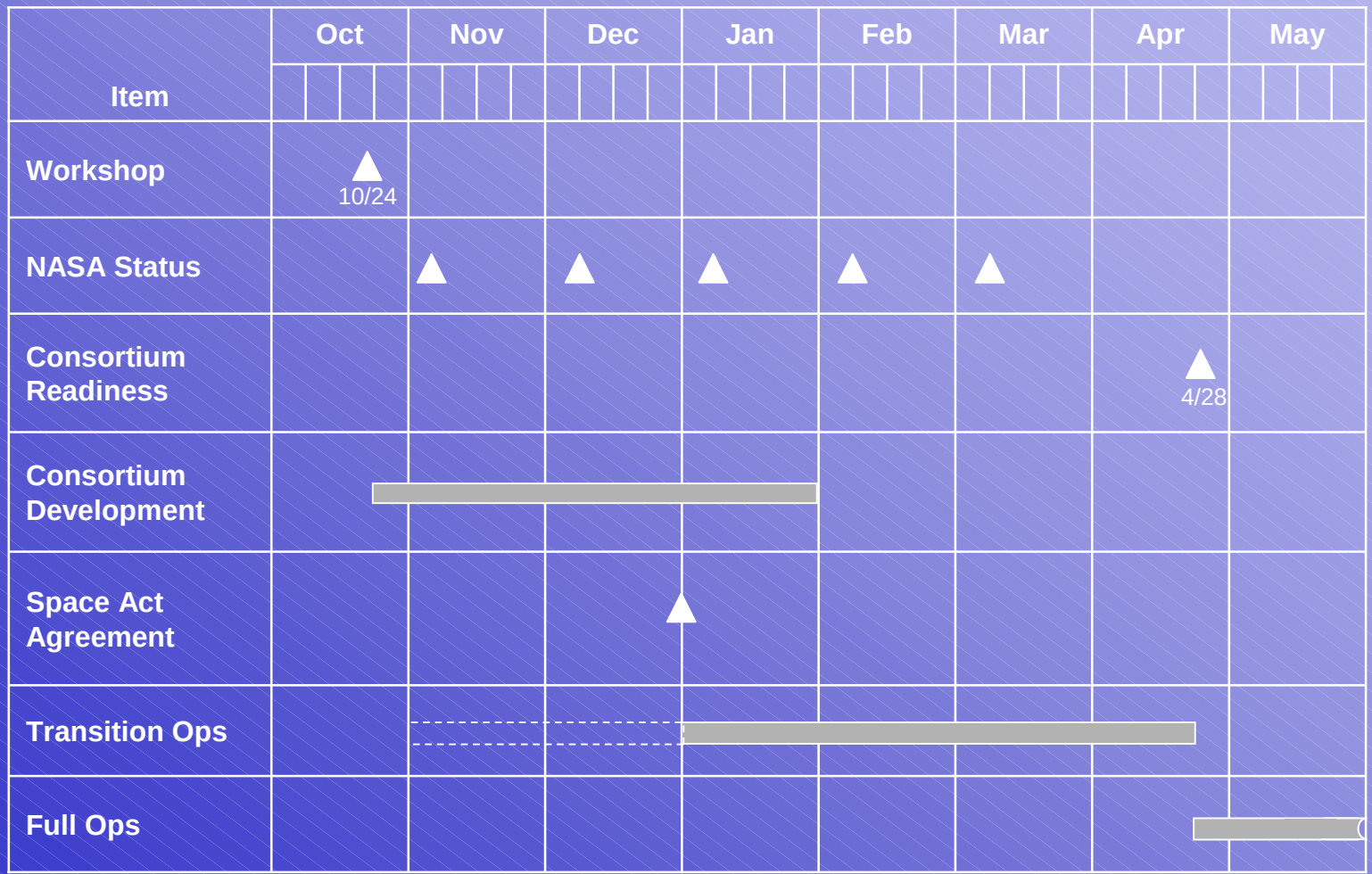
Timeline



Consortium Approach

Joanne Poe JD

Flowen

Cleveland Ohio

216.533.5490

Flowen@worldnet.att.net

Consortium Approach

- Why a Consortium?
  - Due to the high level of interest in using ACTS, a fair and open environment is needed to allow & encourage the greatest participation
  - ACTS operation costs are probably prohibitive for an individual or single entity to assume
  - A collaborative environment fosters synergy and insures fair and worthwhile use of ACTS

Consortium Approach

- Purpose of the Consortium
  - Leverage federal, state, private and academic resources to support education and research based activities related to Ka-band communications systems and operations
  - Act as a catalyst for businesses developing advanced communications products and services
  - Support economic invigoration in Ohio by providing advanced technology and facilities to aid in building the communication infrastructure needed for the future

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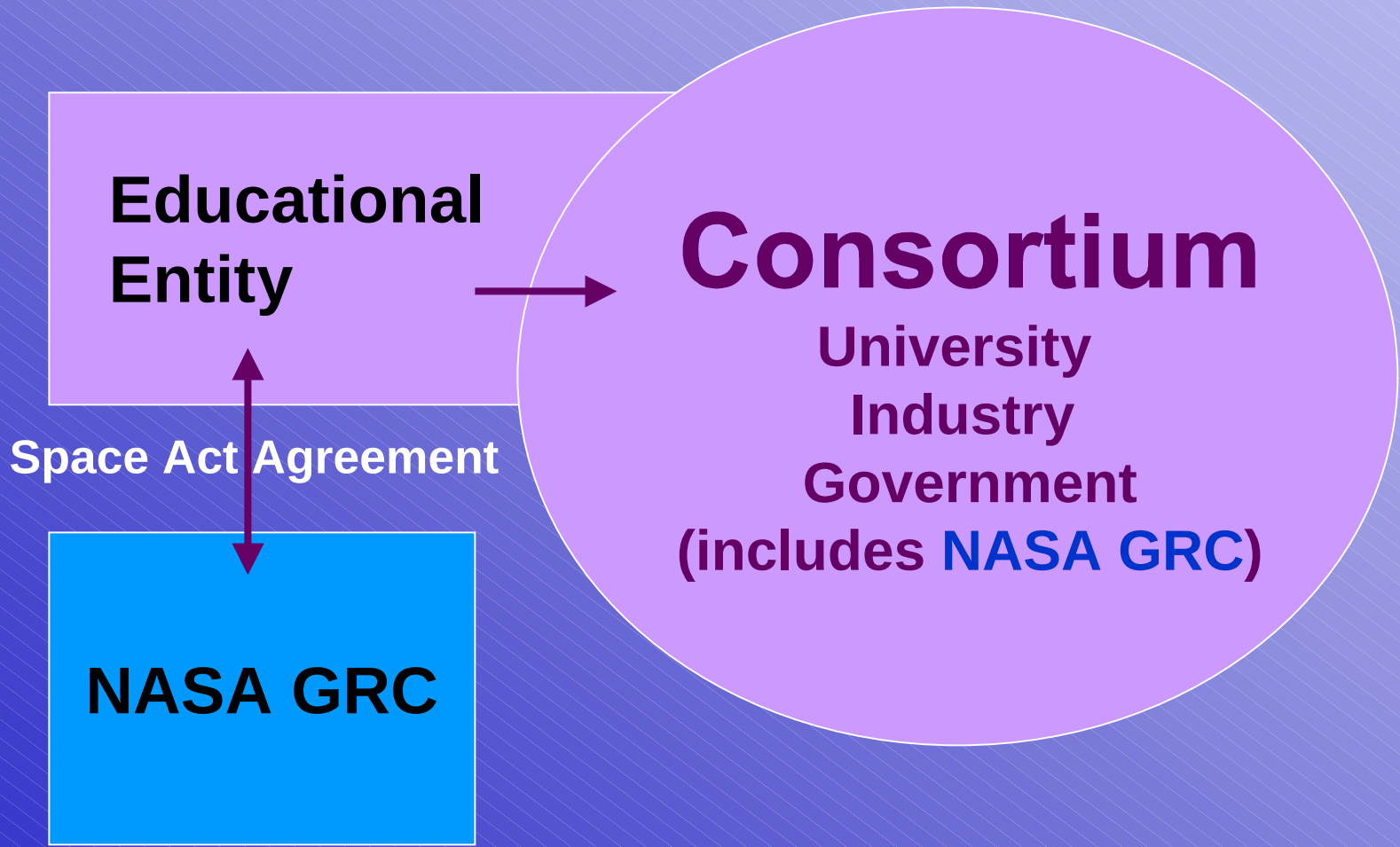
Consortium Approach



Consortium Approach

- Formation of the Consortium
  - A Space Act Agreement (SAA) between NASA GRC and one educational entity:
    - allows a Consortium access to ACTS
    - requires the entity to form, (or arrange for the formation of) the Consortium *at no cost* to the government. And,
    - requires the entity to assume the **full cost of operations no later than April 28, 2001.**

Consortium Approach

- Additional conditions of the SAA:
  - NASA maintains licenses to operate
  - Spacecraft must remain at 105.2° West orbit
  - Consortium membership and access to ACTS must be open to all U.S. entities
  - Use of ACTS can not compete with commercial services provided by industry
  - Consortium responsible for compliance to export laws, data rights regs, existing S/W licenses and nondisclosure agreements

Consortium Approach

- Interest from Academia and Government

Ohio University
Georgia Tech
Miami University
New Mexico State
Wright State
University of Cincinnati
USRA
Florida State
Ohio View
US Naval Academy
Purdue University
Texas A&M
Florida Atlantic
U of South Florida
U of Akron
Kent State University
Center for Leadership Education
Ohio Supercomputing Center
4 Federal Research Labs

Consortium Approach

- Interest from Industry

Advanced Comm Tech
Andrew Corp
Broadtier Comm Inc
E-merging Tech Group
General Dynamics
Honeywell Tech
Motorola
Naknan
Smart Coast
Wild Blue
Infinite Global Infrastructures
ComSearch
Honeywell
Lockheed Martin
General Dynamics
Space Ops International
Andrew Corporation
Tech & Business Strategies

Consortium Approach

- Commitments

  The Ohio Board of Regents (OBR)

  – has accepted all conditions required to execute the SAA
  – is arranging for the formation of a consortium to benefit *all* constituencies: government, university and industry
  – is identifying funds for 4 years of ACTS' operations
  – is securing funding commitments from 25 universities in Ohio and across the nation

  The Ohio View Consortium

  – has offered 200k to support the ACTS consortium

Consortium Approach

- Summary
  - NASA is willing to extend ACTS operations provided that a Consortium can be formed *quickly* and assume the operation costs NLT 4/28/01. **Time is of the essence!**
  - The academic based Consortium must allow open membership and/or access to ACTS.
  - Commitments by the OBR and the Ohio View Consortium are providing a good foundation and impetus to jump start the process.

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Consortium Approach

- The OBR and Ohio University are hosting a breakout session to discuss the Consortium.
- The session is today, after the technical briefings.
- Organizations interested in membership or in using ACTS are encouraged to attend.

Spacecraft Operations Status

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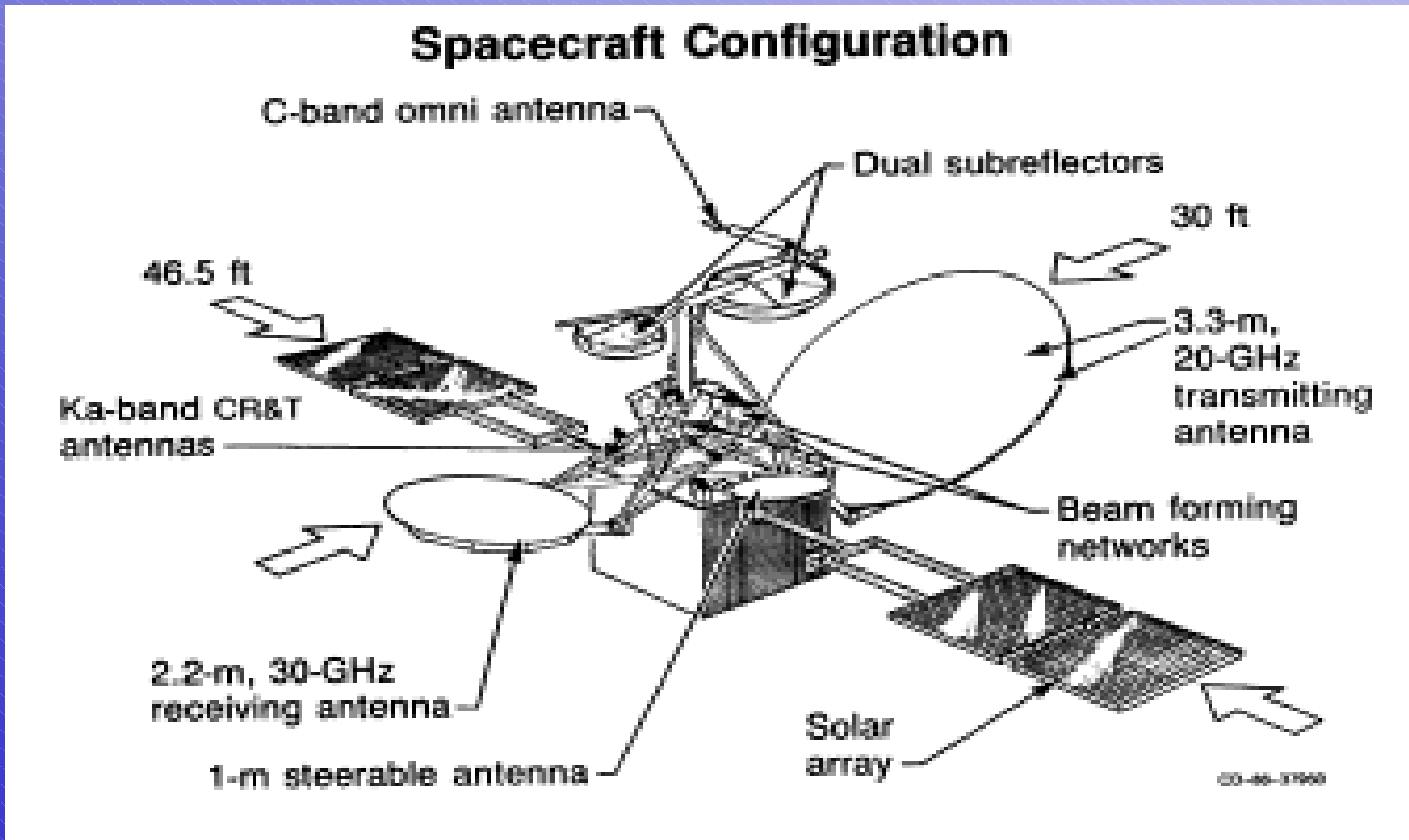
Spacecraft Configuration



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Spacecraft Subsystem Status

Power: Solar array margin (300w.) good for many years on-orbit
Payload shutdown nightly in spring and fall eclipse season.
Battery cells well matched. DOD < 36%

CR&T: Ka band primary. C band backup. Full redundancy except CBT
NGS link margins: TLM: 14 dB
CMD: 21dB hi-rate, 27 dB lo-rate
Periodic ranging for OD and ephemeris generation

Propulsion: No stationkeeping required. Cannot disturb parking orbit stability at 105.2W +/-0.15 °.
Est. <3# fuel. Sufficient for > 4 years momentum unloading .

Thermal: Primary and backup heaters supplement heat pipes

Attitude Control: Redundant hardware. Inclined Orbit Compensation
Autotrack discontinued (too operator intensive as orbit inclination increases)
Earth sensor (pitch, roll) and sun sensor (yaw) inputs to attitude processor.
Momentum wheel and magnetic torquers provide control.
Typical pointing: pitch +/- 0.06°
(Oct. '00) roll +/- 0.1° (until 2° pivot limit ~ Feb. '01)
yaw +/-0.5° " "

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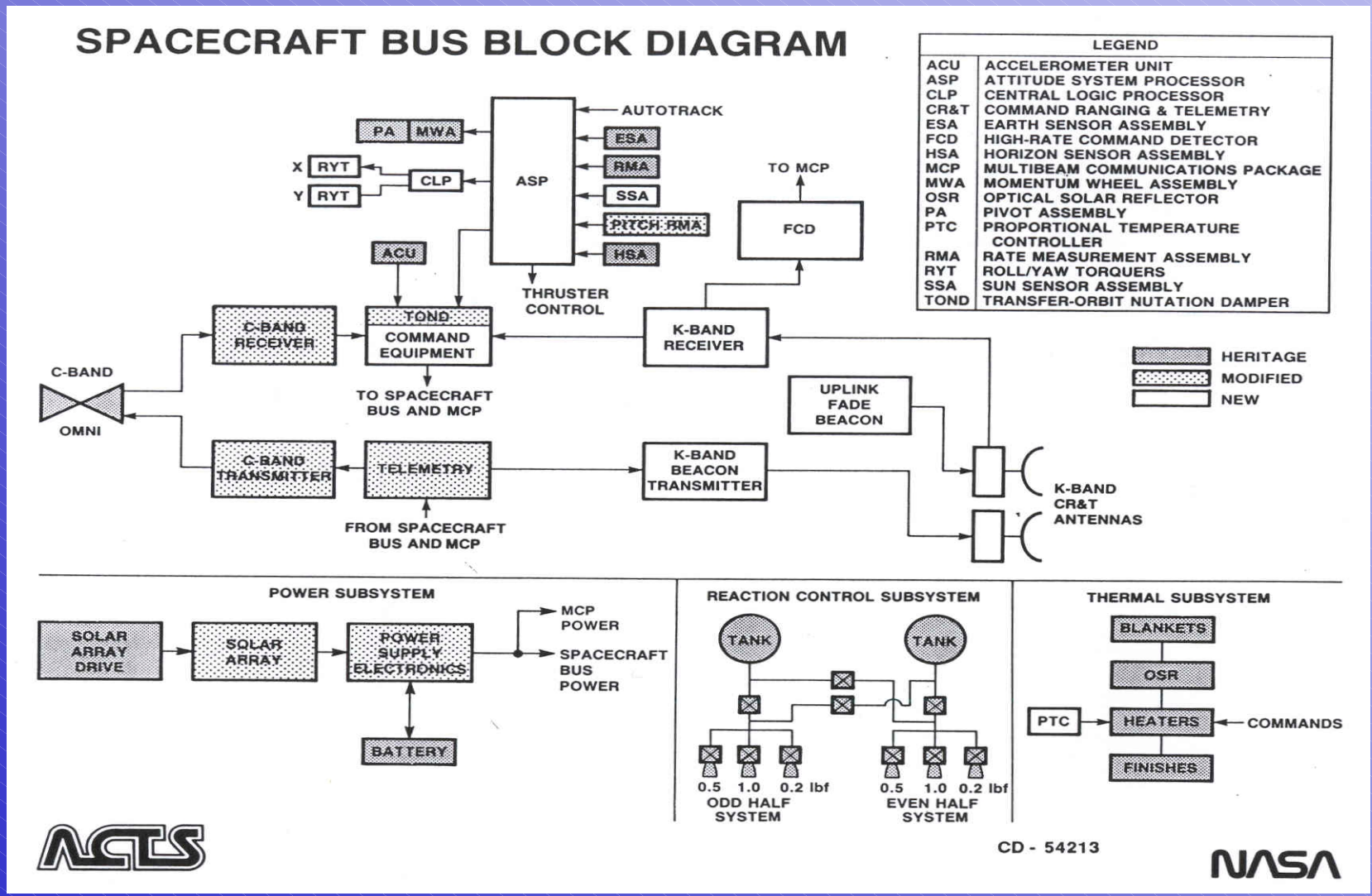
Spacecraft Subsystem Status



Communication Payload Status

Wideband Transponders: 4 for 3 redundancy still available.
46 watt TWTAs with 900 MHz bandwidth
Actual link capacity determined by ground station.

Baseband Processor: Enables DAMA/TDMA network of T1 VSATs via spot beams.
Ground software has range rate/timing limitations in inclined orbit.
Requires fully functional Master Control Station and T1 VSATs
Operation discontinued due to limited resources/excessive overhead.

Microwave Switch Matrix: Enables 3 channel bent-pipe transponder
Controls spot beam selection.
Continues to support USAT links.

Multi-Beam Antenna: Select from 51 spot beams over CONUS
50 spot beams with 0.30° beamwidth, EIRP up to 69 dBW.
Beam pointing relative to Cleveland and attitude stability.
One steerable beam, 1° beamwidth (~10 dB less gain).
MBA periodic thermal distortions characterized.

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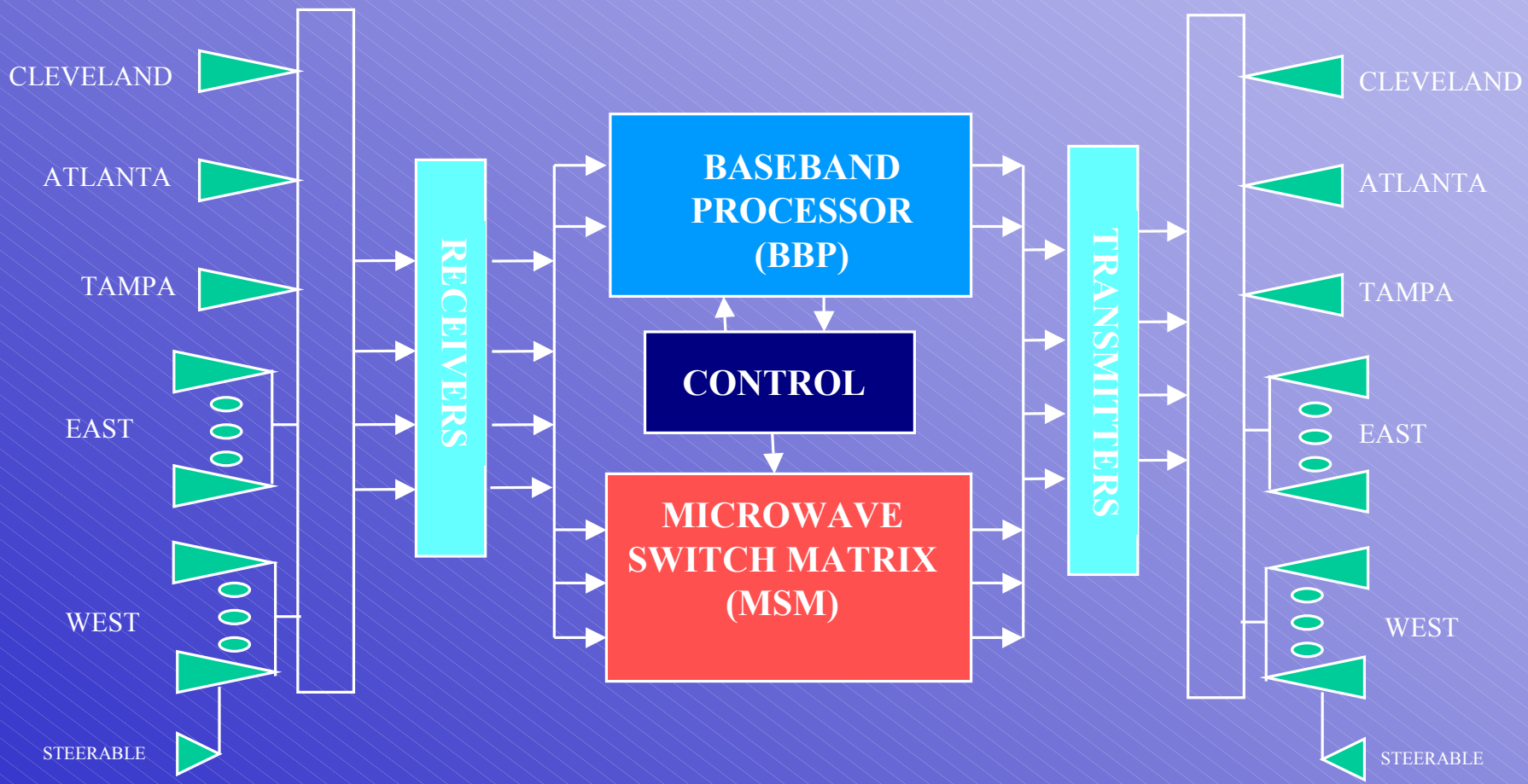
ACTS Communications Payload



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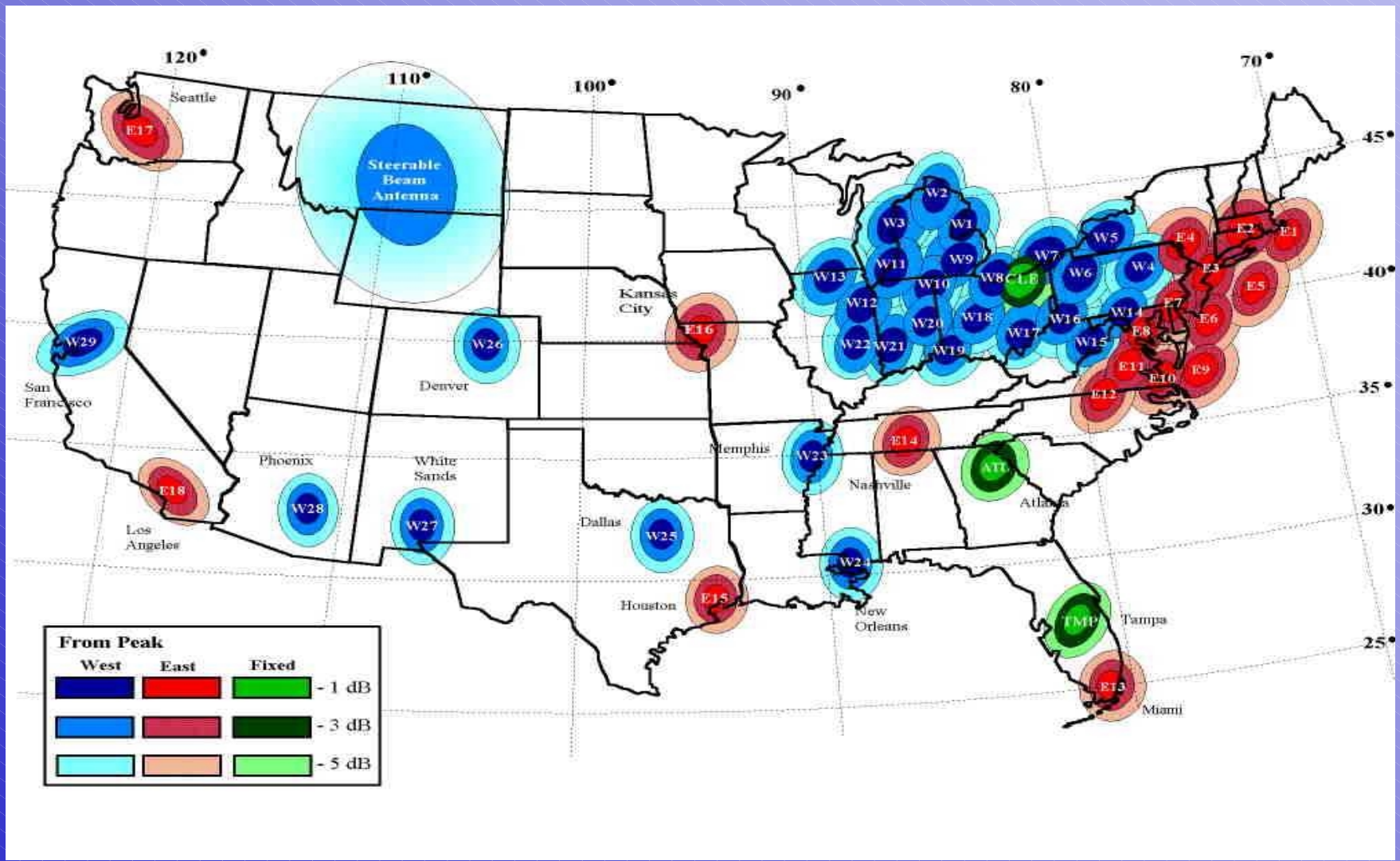
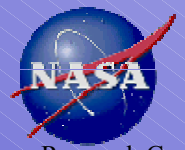
ACTS Spot Beam Location





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ACTS Operations

Spacecraft Control

Lockheed Martin Space Systems (originally RCA) under contract for operations
- manages spacecraft operations and makes recommendations to NASA
- Has core team of experienced personnel at CPC (Newtown, PA)
- Has access to spacecraft designers and analysts
- Familiar with proprietary software, documents and procedures
- Uses GRC NGS (government property) except C-band.

NASA Ground Station

LM Global Telecom (formerly Comsat) under contract for operations & maintenance
- Comsat designed, built and integrated NGS
- Has core team of experienced personnel at NGS
- Entire facility is government property
- Served as Experiment Network Hub
- No new purchases planned. Make best use of existing equipment.

License

NASA experimental license valid until Dec. 31. Extension requested.

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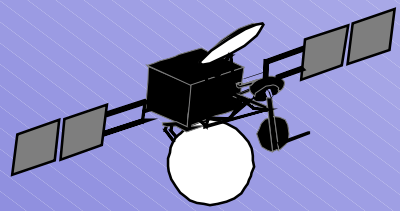
ACTS Operations



NGS @ NASA GRC
RF/TT&C equipment
satellite control consoles
1 or 2 shifts

Phone lines

LM ASOC
Newtown, PA
satellite control consoles
24 x 7 staff

Phone lines

C-band station
RF/TT&C equipment

staff on-call

Maintain antennas and RF equipment
Maintain TT&C equipment
Comm link monitor and diagnostics
Program management
Satellite control backup
Conjunction analysis

Spacecraft engineering
Spacecraft controllers
Orbital analyst
Operations planning
Primary satellite control

Backup RF link

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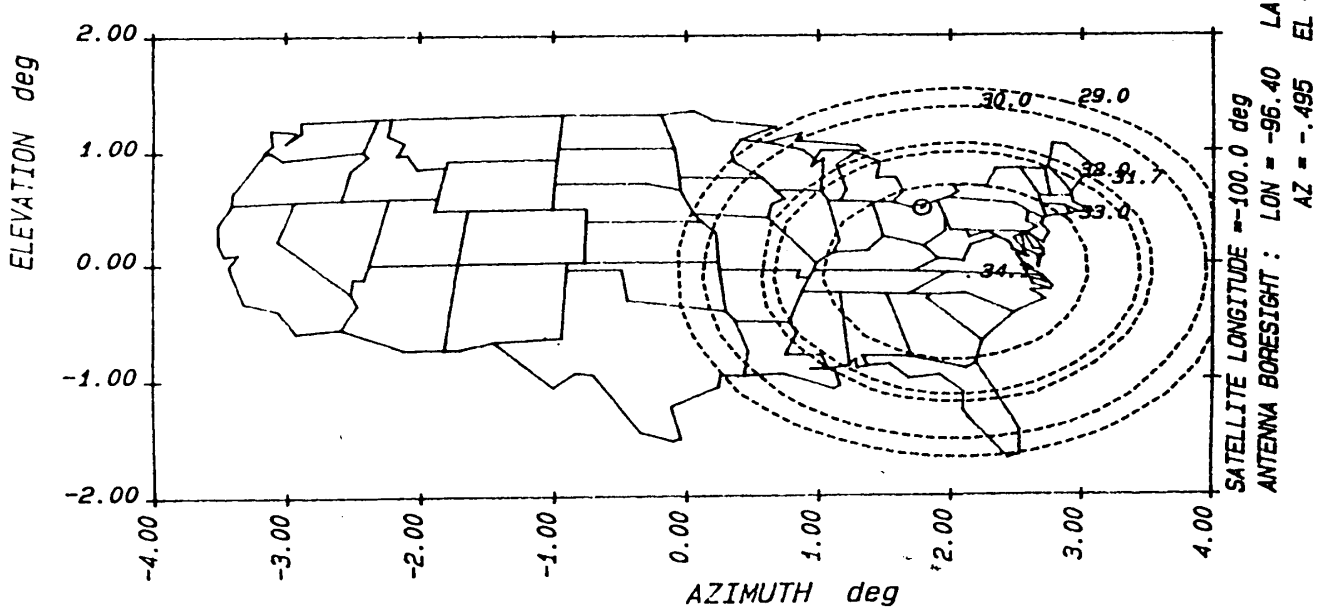
Ka-Band CR&T Antenna Assembly

Command Receive Pattern—Measured with Surrounding Thermal Blankets
29.975 GHz H-POL



ACTS MASTER GROUND STATION OVERVIEW

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Revised November 1, 2000

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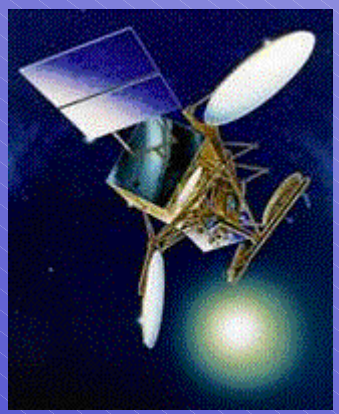
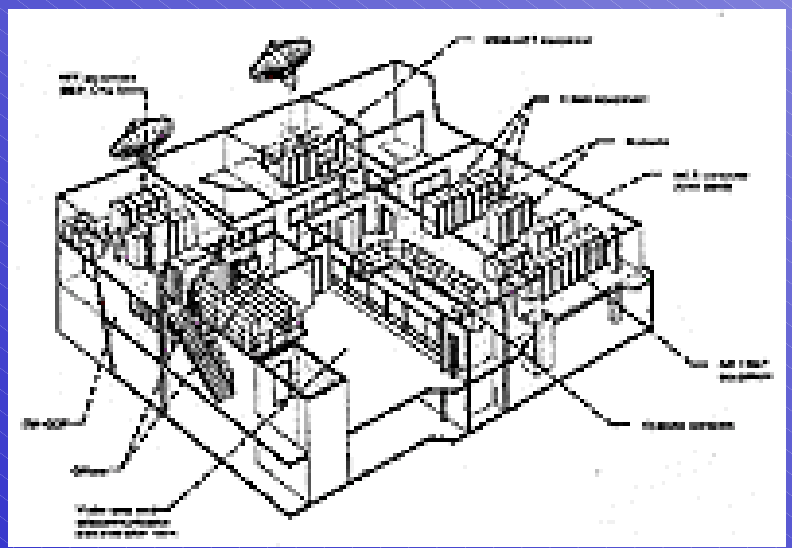
NASA ACTS Master Ground Station



ACTS Program

- Experimental System
- Launched 1993
- Demonstrating New Technologies for Satellite Systems in the New Millennium
- NASA/US Industry Partnership
- LMGT/COMSAT MGS Contractor



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ACTS Master Ground Station

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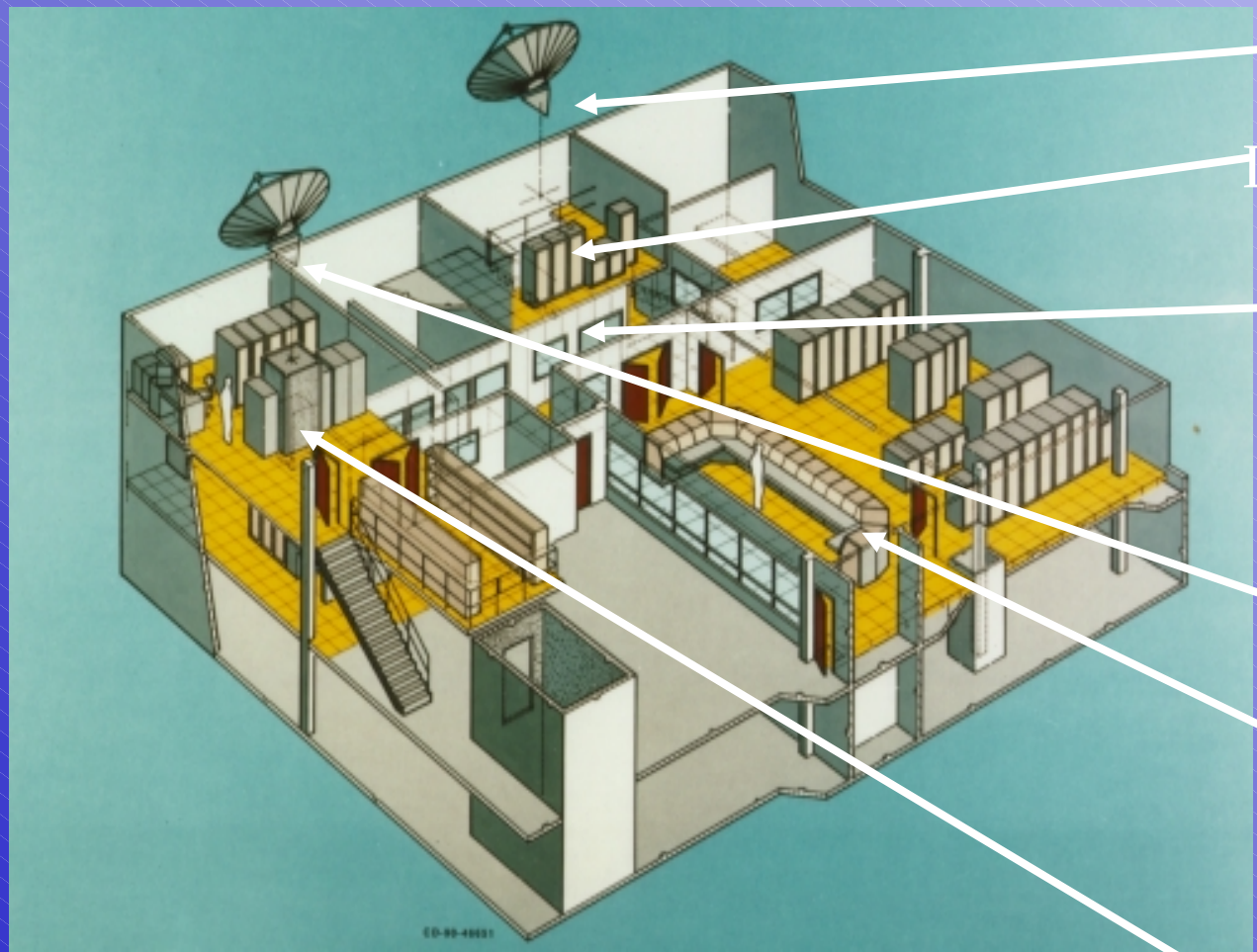
ACTS Master Ground Station



LET Antenna

LET - Instrument Racks

LET Control Room

NGS Antenna

ACTS Control Console

NGS Instrument Racks

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ACTS Master Ground Station

Current MGS Facility:

- Located at NASA Glenn Research Center (GRC), Cleveland, Ohio
- Investment of over $70M
- Fully Functional Gateway Class Ka-band Earth Station:
  - Two 5-meter dishes and RF systems with high EIRP (80 dBW) and G/T (30 dB/K), dual polarization and redundancy connections
  - Communications and TT&C facilities
  - Designed for continuous operation as major network hub
  - Redundant facility systems: UPS & HVAC
  - Well developed terrestrial communications hub:
    ISDN, OC-3/OC-12, ATM, T1, Telco/PBX
- 24 Hour Commercial style operations, maintenance and technical support since 1993 by LMGT COMSAT staff experienced in commercial operations and experimental testing.
- Proximity to other GRC facilities:
  - ATS master earth station (VHF GEOS ATS-1 & ATS-3)
  - 3 Ku-band earth stations, including 8.1-meter INTELSAT standard E3
  - Simulation/Test Bed Facilities

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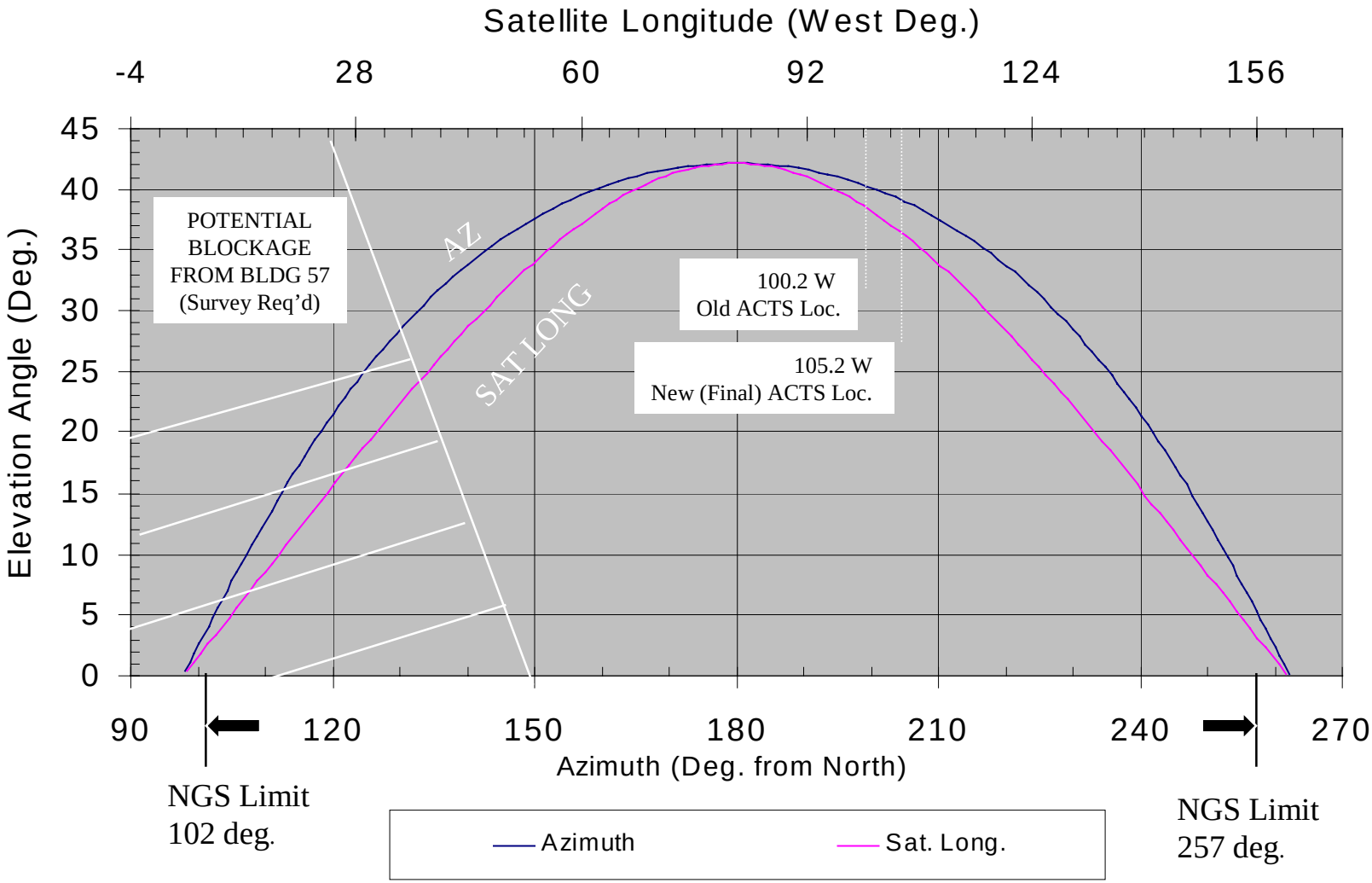
Geosynchronous Arc from GRC



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ACTS Master Ground Station

- Master Ground Station (MGS) includes two systems:
  - NASA Ground Station (NGS)
  - Link Evaluation Terminal (LET)
  - Both used for TT&C and Communication functions with ACTS System

MGS STATION PARAMETERS:

- NGS Antenna
  - 5.5 Meter Diameter Reflector
  - Cassegrain feed with Beam Waveguide System
  - Optics (reflector & beam waveguide system) good Ku - V bands
  - Corregated feed horn good 20 - 40 GHz
  - Diplexer (Polarizer and OMT) tuned for commercial Ka- frequency band
    - Dual linear polarization on Tx and Rx
    - Polarization adjustable with 180 deg. polarizer
    - Possible to add 90 deg. polarizer for CP operation
    - Spare diplexer available – retune for other uses
  - Step Tracker with memory track mode
  - Antenna Manufacturer: TIW
  - Diplexer Manufacturer: LMGT COMSAT Laboratories

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ACTS Master Ground Station

MGS STATION PARAMETERS (Cont.):

- NGS RF System Equipment
  - 3-for-2 HPA Redundancy
  - 3-for-2 LNA Redundancy
  - Can Transmit & Receive 3 Carriers
  - Beam Waveguide System Allows Tx & Rx equipment location indoors beneath antenna
  - Waveguide
    - Tx WR-28 (26.5 - 40.0 GHz)
    - Rx WR-42 (18.0 - 26.5 GHz)
  - Multiple Up- and Down-converters
    - High IFs allow wideband signals & flexibility in choice of IF
    - Retuning possible.
  - Beacon receive system – U/L & D/L bands
  - Provision for Testing
    - Multiple Loopback Signal Paths
    - Ports for Spacecraft Simulator
  - Interfacility Link to Communications and Control Area

ACTS Master Ground Station

MGS STATION PARAMETERS (Cont.):

- Other MGS Station Equipment:
  - TT&C equipment
  - TDMA Reference and Traffic Terminal communications equipment
  - Related computer equipment for use with BBP Operations
  - Terrestrial comm equipment - ISDN, OC-3/OC-12, ATM, T1, Telco/PBX
  - Cesium and Rubidium Time Standards
  - Spacecraft Simulator (EM-CEP)
  - Analog & Digital Test Equipment
  - Large Communications Equipment and Control Console Areas

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ACTS Master Ground Station

MGS SYSTEM PERFORMANCE

- NGS Antenna

		30 GHz	20 GHz
Gain (dBi)		60.8	58.1
Beamwidth (deg)	3 dB	0.134	0.192
	1 dB	0.083	0.123
Polarization		Linear V&H	Linear V&H

- NGS Frequencies
  - Up-link: General 29.0 – 30.0 GHz
    ACTS: 29.180- 29.346 GHZ Comm / 29.975 GHz TT&C
  - Down-link: General 19.2 – 20.2 GHz
    ACTS: 19.384 - 19.550 GHz Comm
    20.185 / 20.195 / 27.505 GHz Beacons

NGS

- Noise Performance

Freq (GHz)	Tant (K)	Tsys (K)	G/T (dB/K)
19.47	123	570	30.3
20.185/20.195	123	567	30.7
27.505	121	1687	27.8

- NGS EIRP: Adjustable 68 - 80 dBW
  - HPAs 29.16 - 30.0 GHz @ 150 W saturated output

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ACTS Master Ground Station

MGS SYSTEM PERFORMANCE (continued)

- Link Margins in ACTS Operations

BBP Links	Link Margin (dB)
Up-Link	
110 Mbps (74 dBW EIRP)	14
27.5 Mbps (68 dBW EIRP)	14
Down-Link – 110 Mbps	20

Link Margins shown are above 5E-07 BER in Uncoded Operation
Coded operation (Rate ½ FEC plus 50% bit rate) adds 10 dB to margin
High margins for rain fade also mitigate sun interference effects

TT&C Links	Link Margin (dB)
Up-Link (79 dBW EIRP)	
High Rate Commands	21
Low Rate Commands	27
Down-Link Telemetry	14

Fade Beacons	C/N (dB) in 400 Hz
20.185/20.195 GHz	40
27.505 GHz	32

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ACTS Master Ground Station

LMGT COMSAT Laboratories Role in ACTS:

- Design, Development, Integration and Test of Commercial Master Ground Station Equipment at LMGT COMSAT Laboratories, Clarksburg, MD:
  - Network Control, TDMA and RF Terminal Equipment:
    - Real Time Control of Satellite Baseband Processor and TDMA Network
      - Bandwidth on Demand
      - 2-to-3 second setup for single channel circuits
      - 2-to-10 second setup for multi channel circuits
    - Adaptive Rain-fade Compensation
      - FEC and burst rate reduction
    - Payload TT&C
    - Propagation Measurements
    - Real Time Data Collection
    - Off-line Processing of Experiment Data
- System Integration and Test with Spacecraft at Satellite Manufacturing Facility – Lockheed Martin Space Systems, Newtown, PA
- System Operations and Test : 24x7 since 1993 at NASA GRC, Cleveland, OH together with Lockheed Martin Space Systems

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LMGT COMSAT ACTS O&M Team

Support of Post-ACTS Missions:

- ACTS Operations End this Year
  - Spacecraft has now been moved to final 105.2 deg W. orbital location
- Potential New GRC MGS Missions:
  - University Instructional Test Facility
  - Other (synergy possible)
    - Transition to Commercial assets for NASA mission support
    - Work with/support of new Commercial Ka-band systems as NASA Gateway Station
    - MGS equipment is designed for operation in commercial Ka-band
    - Refittable to other frequency bands & requirements.

The LMGT COMSAT Team at NASA GRC:

- On-site support at GRC for ACTS Space Operations since 1992
- Experienced and diverse skills in engineering, technical and operations areas
- Direct connection to support organization: LMGT COMSAT Laboratories
- Commercial organization with tight focus on mission and cost control
- Major contributor to success of ACTS mission. Several Awards from NASA.

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University Instructional Test Facility

- On-The-Air Laboratory for Satellite Communications Engineering and Operations:
  - Spacecraft Bus TT&C
  - Communications Networks & Equipment
    - Bent-Pipe Transponder
    - Onboard Processor w/limitations
    - Combination
  - Terrestrial Networks & Equipment
  - Earth Station Equipment
- Simulation Laboratory for above areas
- Other applications:
  - Antenna Measurements
  - Propagation Studies
  - Radio Astronomy

ACTS Extension Ground Station Capability

Richard C. Reinhart

USAT & LET Operations Manager

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ACTS Program Extension Work-Shop

NASA Glenn Research Center

Cleveland, Ohio October 24, 2000

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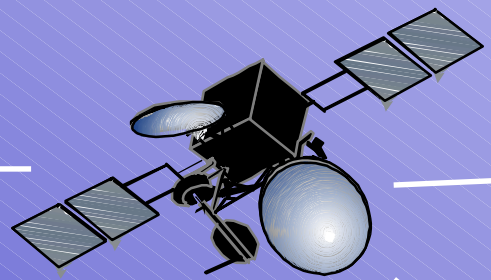
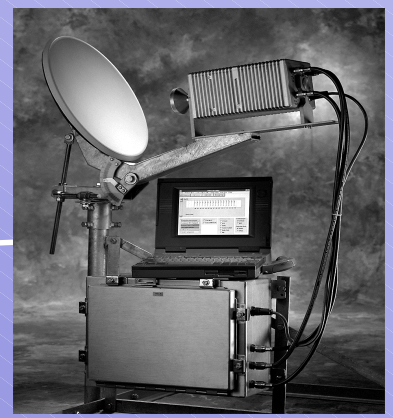
ACTS Ground Stations

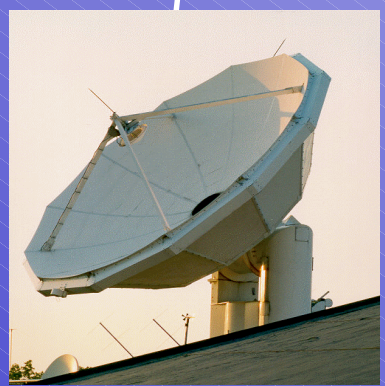
1.2m VSAT





0.35/.6/1.2m USAT

3.4 m HDR



5.5 m NASA Ground Station

4.7 m Link Evaluation Terminal

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ACTS Consortium Experimenter Ground Stations

- NASA will provide 4 USAT ground stations to Consortium for experiments
  - 1.2m reflector antenna
  - Tracking mount, controller, computer
  - Ka-Band transmit and receive electronics
  - Spare parts for I/O mounts, as available
- Link Evaluation Terminal (LET) @ GRC will be made available to Consortium members for experiments
- Other terminals developed by Consortium or provided by industry (independent of NASA)
  - JPL, CRC, AFRL, Raytheon, LM, NRL

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Ultra Small Aperture Terminal Description & Features

- Small, transportable ground station
- Fully Interactive Link
- Point-to-point, multicast, FDMA network configurations
- Ideal for asymmetric data rate applications
- Desktop video, teleconferencing, Internet access, telemedicine, remote control, distant learning...
- 70 MHz IF interface to user provided modem
- Limited station diagnostics by design to reduce cost and size

USAT with .6m reflector antenna

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USAT Ground Station Configuration

- **Antenna**
  - 120 cm with offset feed
- **Characteristics**
  - Tx Freq 29.4 to 29.8 GHz
  - Tx Power 30 dBm (1 watt)
  - Rx Freq 19.7 to 20.0 GHz
  - Bandwidth 40 MHz
  - Noise Figure 2.5 dB
  - 70 Mhz Interface
  - 2 year old electronics
- **Tracking Station**
  - Equipped for inclined orbit operation

USAT Ka-Band Transmit and Receive Electronics

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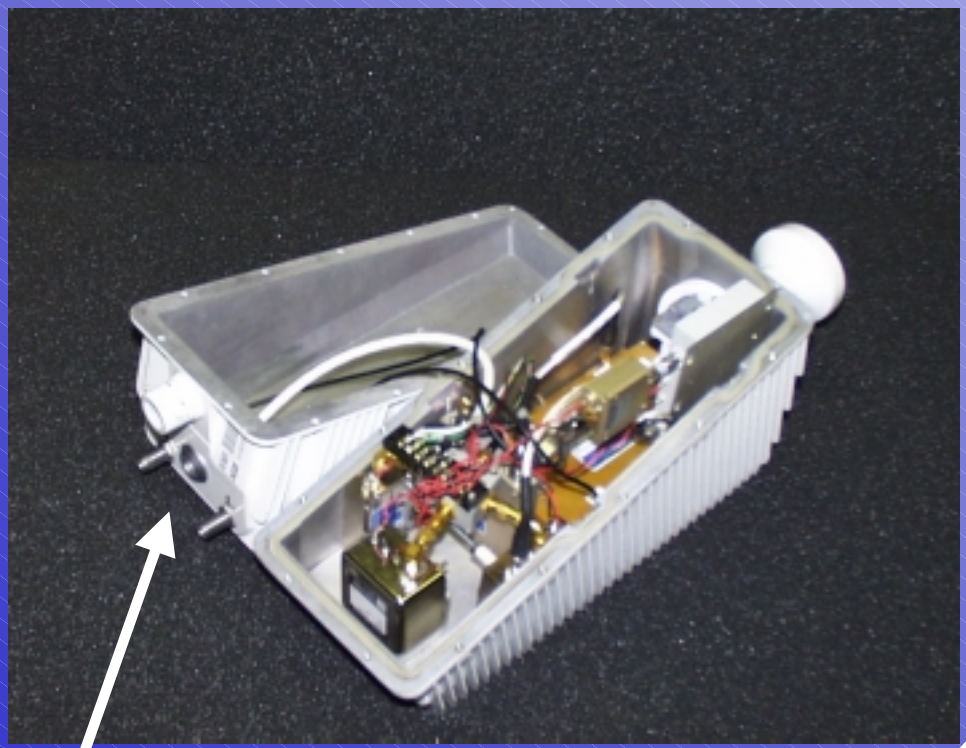
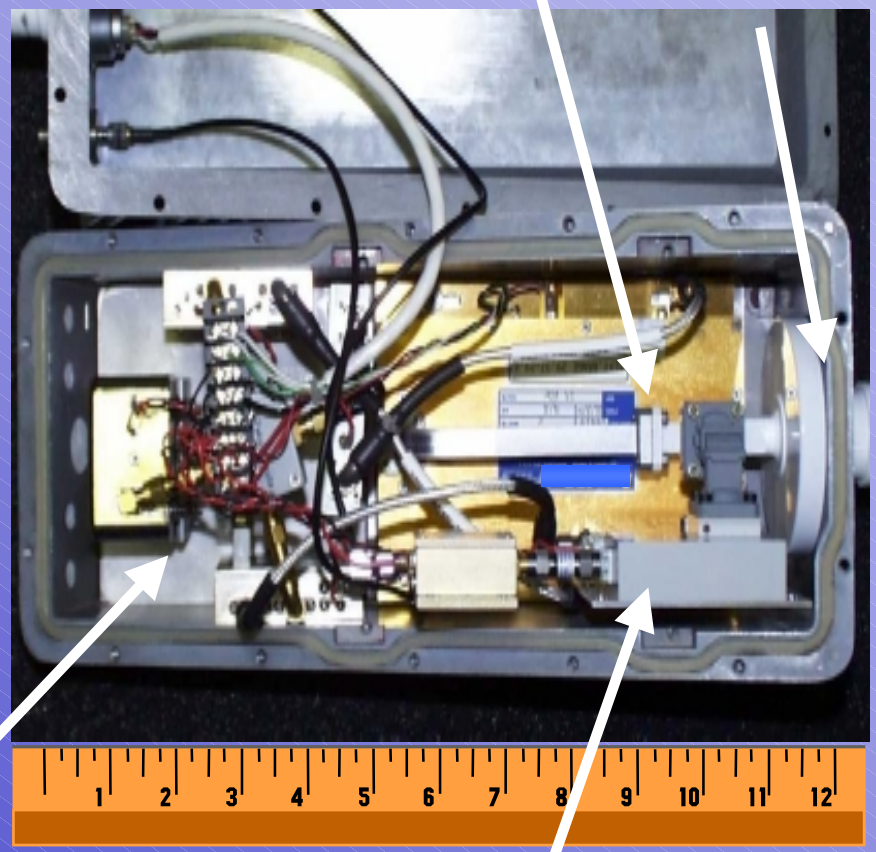


70 MHz
IF Interface



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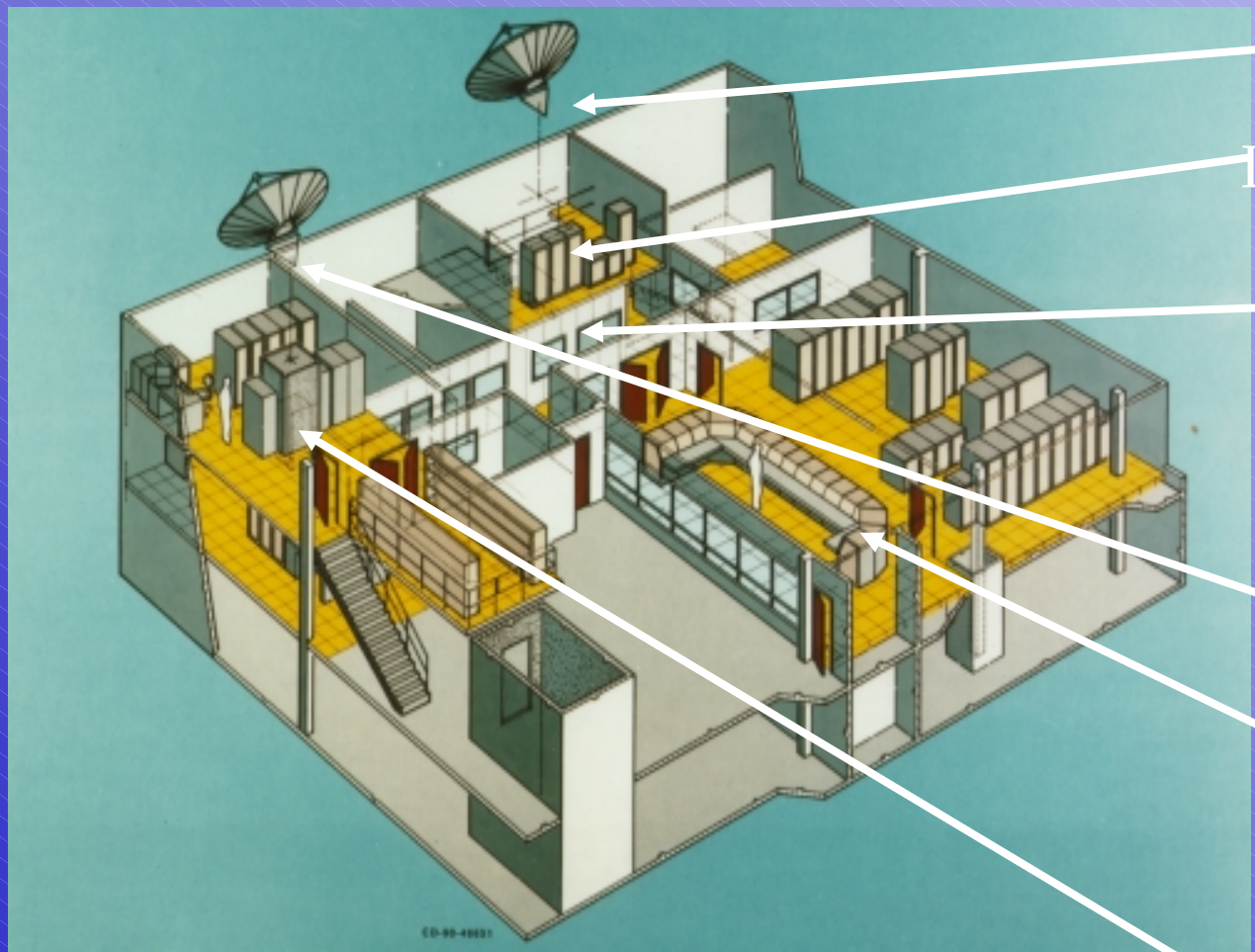
ACTS Control Facility @ GRC



LET Antenna

LET - Instrument Racks

LET Control Room

NGS Antenna

ACTS Control Console

NGS Instrument Racks

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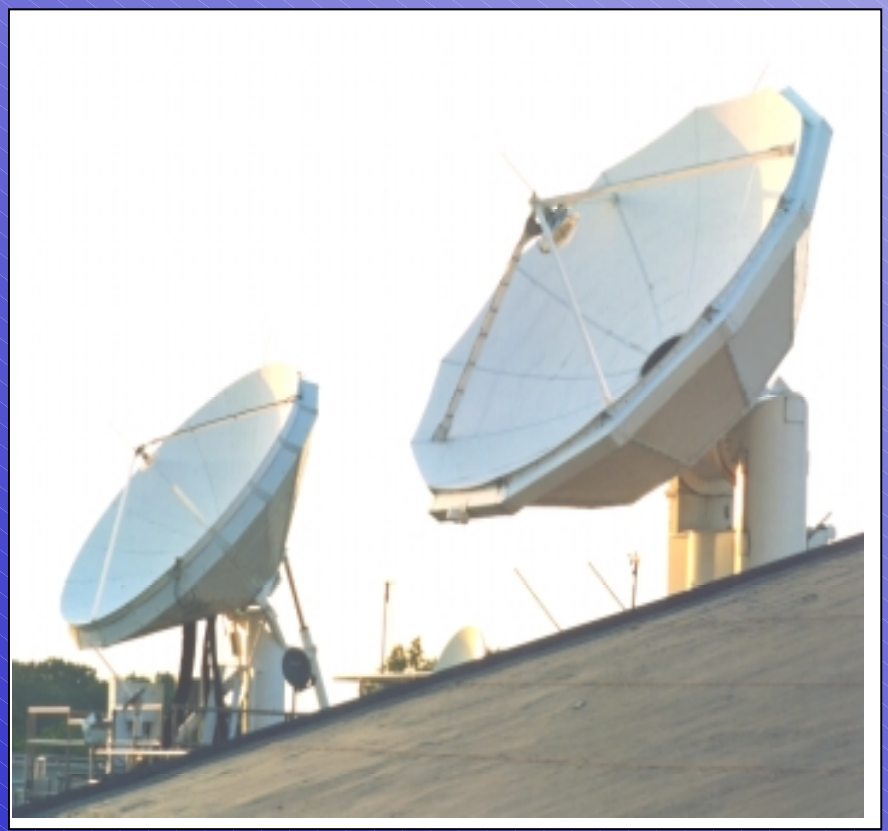
Link Evaluation Terminal (LET)



LET NGS

- 4.7m Cassegrain optic configuration with center feed
- 100W TWTA, recv (NF=3dB), u/c, d/c, loopback equipment in hub
- IF interface of 3 GHz or 70 MHz
- Environment control system maintains hub temperature
- Station computer commands the satellite IFSM via command link
- LET provides back-up for TT&C
- NGS provides backup for LET

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LET - Experiments & Applications

- RF/Microwave, System Engineering & Operations
  - Extensive loopback capability at IF and RF with built-in test equipment
  - Power, frequency, and spectrum monitoring test points throughout system
  - Local oscillator; power, frequency, spectrum, and voltage monitoring and fault indicators
  - TWTA remote control capability
- Hub station for asymmetric links with USAT's
- High rate applications in s/c loopback with user provided modems

Instrumentation racks

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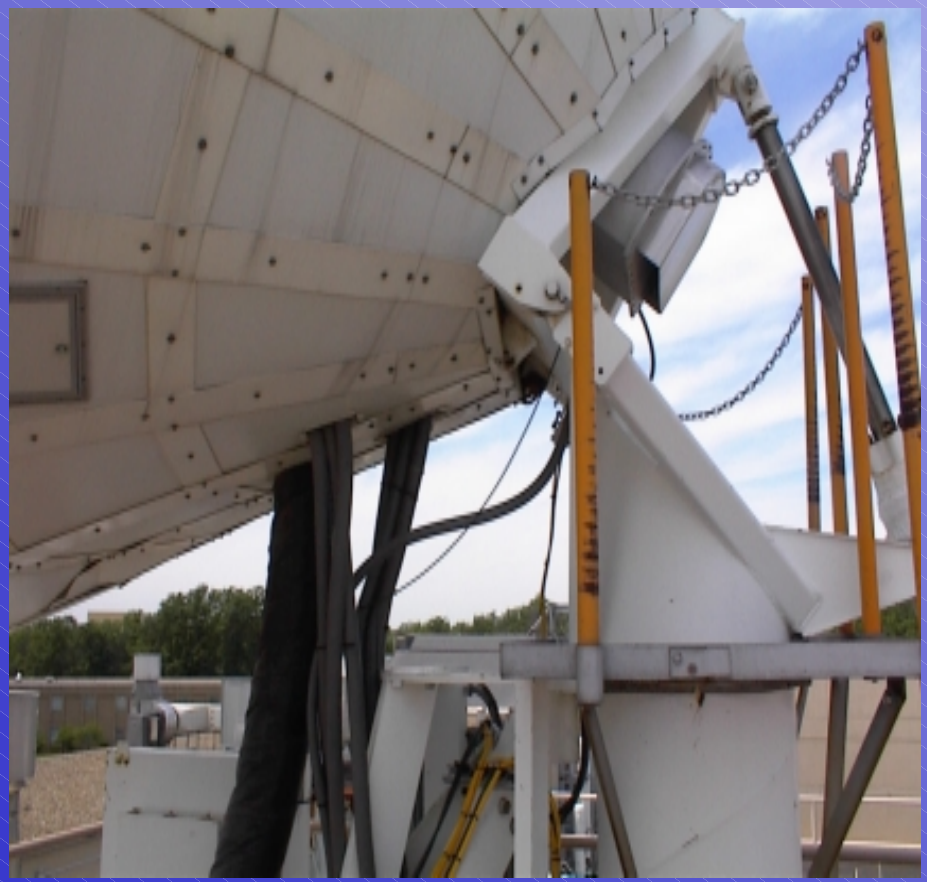
LET - Station Integration



4.7m antenna, rear view
Hub mounted TWTA, LNA

Control Room
IFSM control, data acquisition

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ACTS Ground Stations

NAME	MODE	ANTENNA (m)	HPA (Watt)	EIRP (dBW)	G/T (dB/K)	BURST RATES (Mbps)	DATA RATES (Mbps)	MODULATION
NGS	BBP/ TTC	5.5	200	78	30	U/L: 27.5 or 110 D/L: 110	64 kbps to multiple T1 & T2	SMSK
LET	MSM	4.7	100	78	27	Up to 696	low kpbs to 622 Mbps	BPSK, QPSK, SMSK
USAT	MSM	0.6, 1.2	.25, 1.0, 2.0	35-51	15, 21	Up to 2.5 Msps	U/L: low kbps to 8 Mbps D/L: up to 45 Mbps	BPSK, QPSK, CDMA
HDR	MSM	3.4	120	76	28	Up to 696	311 or 622 Mbps	O-BPSK (OC-3) O-QPSK(OC-12)
VSAT	BBP	1.2	12	60/66	16-18	U/L: 27.5 D/L: 110	1.792 (max)at 64 kbps increments	SMSK

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What does it do?

- LET-USAT Applications
  - High rate product distribution
  - Star network hub
  - Transponder characterization
    - Frequency response, gain, linearity, group delay, etc...
- USAT-USAT
  - Video teleconferencing
  - ATM, Frame Relay, IP networks
  - Mesh network, Internet & protocol evaluation
  - Remote control/operations
  - Propagation research
    - wet antenna, site diversity
  - Incline orbit evaluation

Product Distribution & ISDN Demonstration
Pacific Telecommunications Conference, Waikiki, HI

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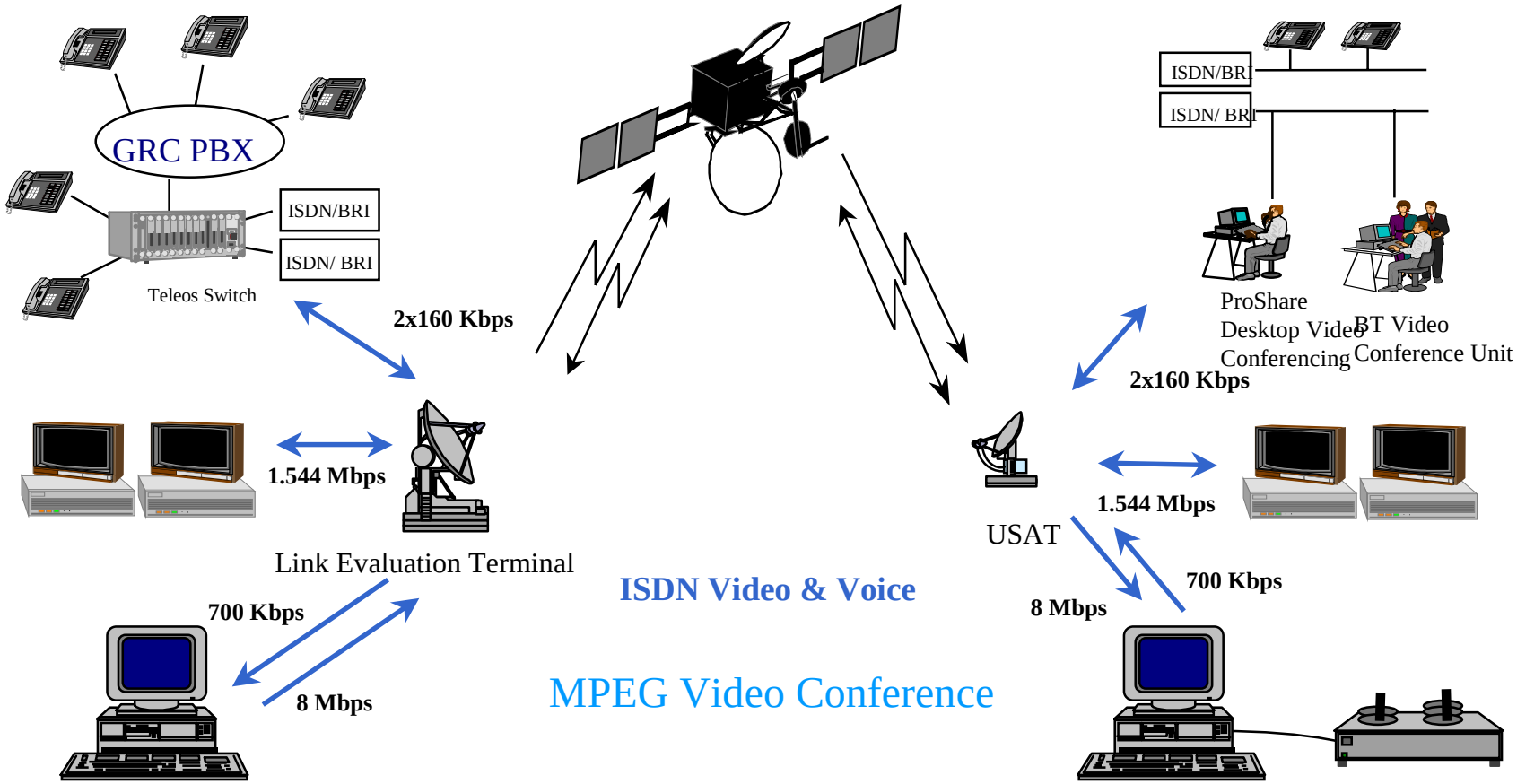

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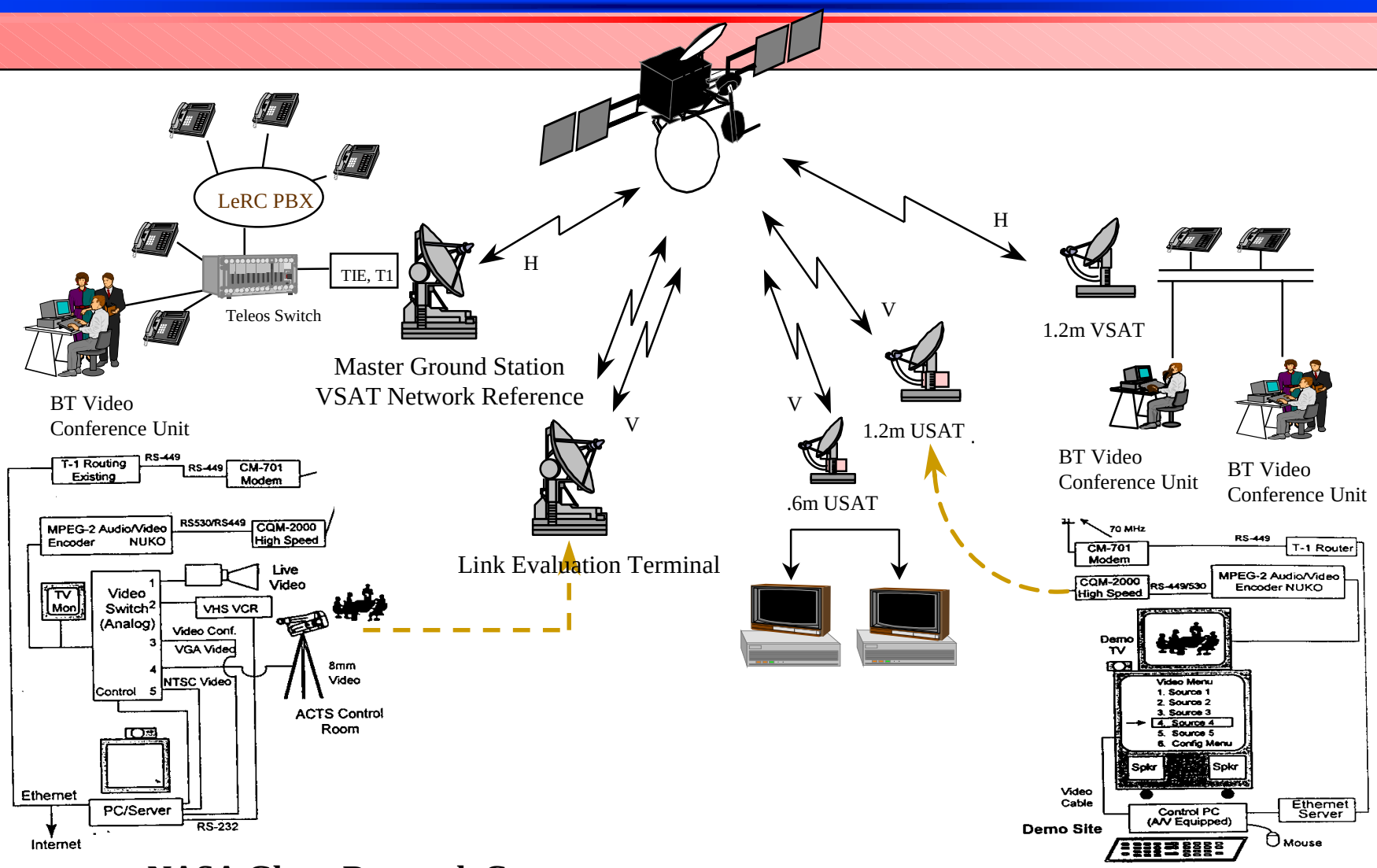
Multimedia, Internet, High Rate MPEG Video, Telemedicine, Video Conferencing, (ISDN)



NASA Glenn Research Center
Cleveland, Ohio

Tech 2006/Telecon XVI
Anaheim, CA

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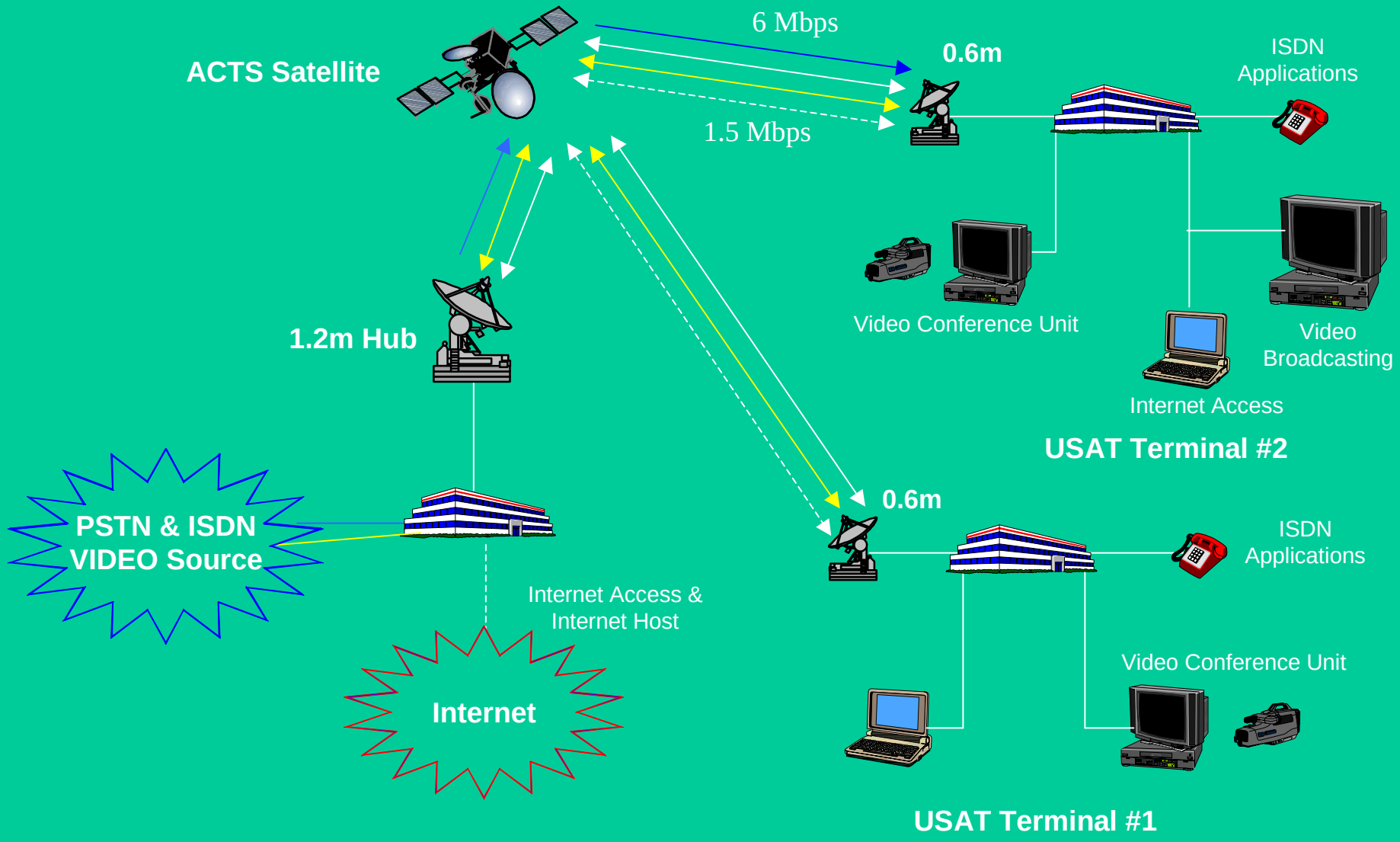
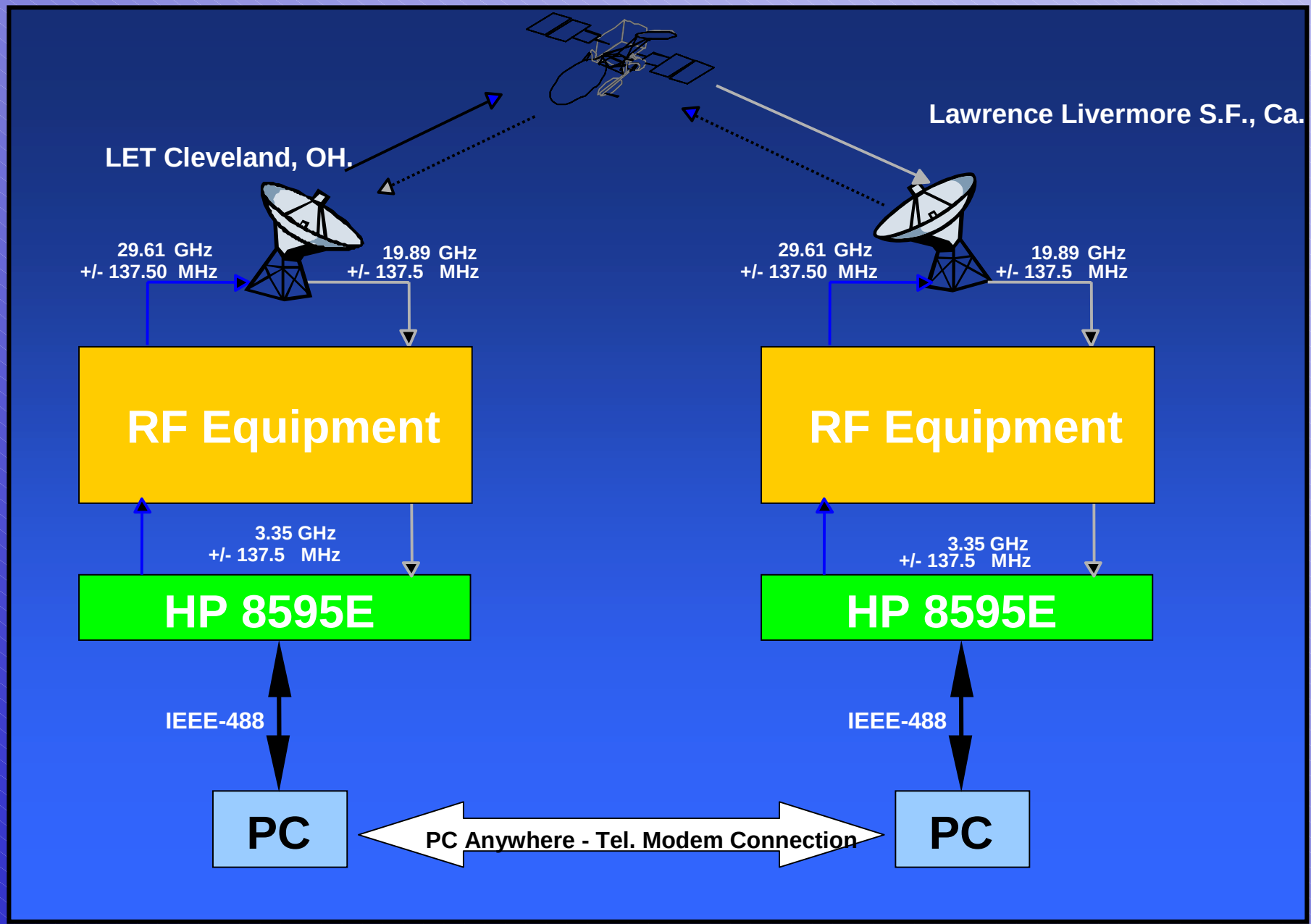
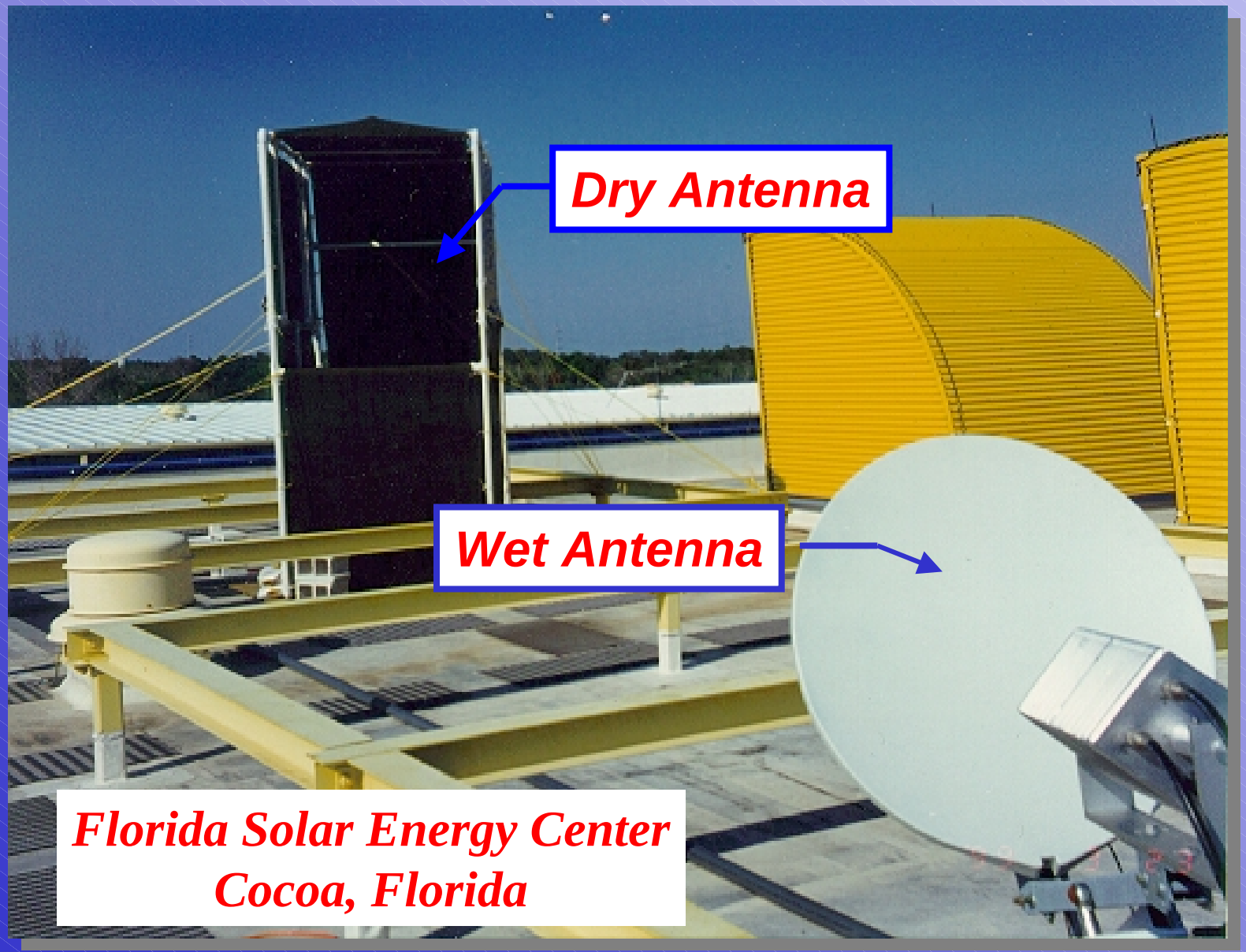
ACTS Demo Configuration
An Example of Multi-Service Platform



Wideband Dispersion System Diagram



Wet Antenna Experiment Setup



Inclined Orbit Operations- Experimenter Stations

- All stations used combination of closed loop tracking & memory track.
- USAT
  - Uses communication signal from other ground station, beacon signal out-of-band
  - Memory track used for off-hours and rain fade events
- LET
  - Uses continuous satellite beacon
  - Memory track used for large rain fade events

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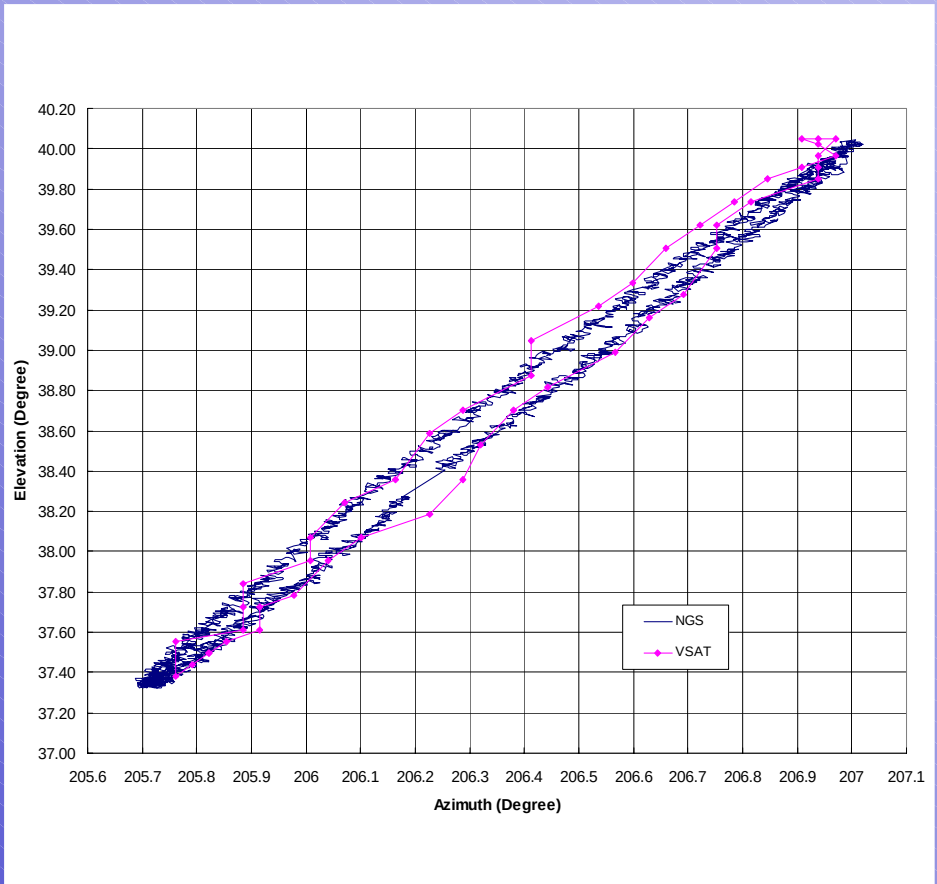
Inclined Orbit - Performance

- 1.2m tracking station compared to NGS co-located at GRC.
- Example indicates < .2^{o} pointing accuracy or < 1dB loss. (prior to move to 105.2°W)



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Proposed Ground Station Operations Summary

	NASA	Consortium
Ground Stations	4 USAT ground stations and access to LET - All stations equipped for I/O operations	Additional stations or industry coordination and involvement
Maintenance & Operations	Maintain LET facility	USAT deployments, maintenance, and operations LET operations
Applications & Experiments	Access to conference proceedings, technical papers and presentations available via http://acts.grc.nasa.gov/	Coordinate and conduct experiments activities

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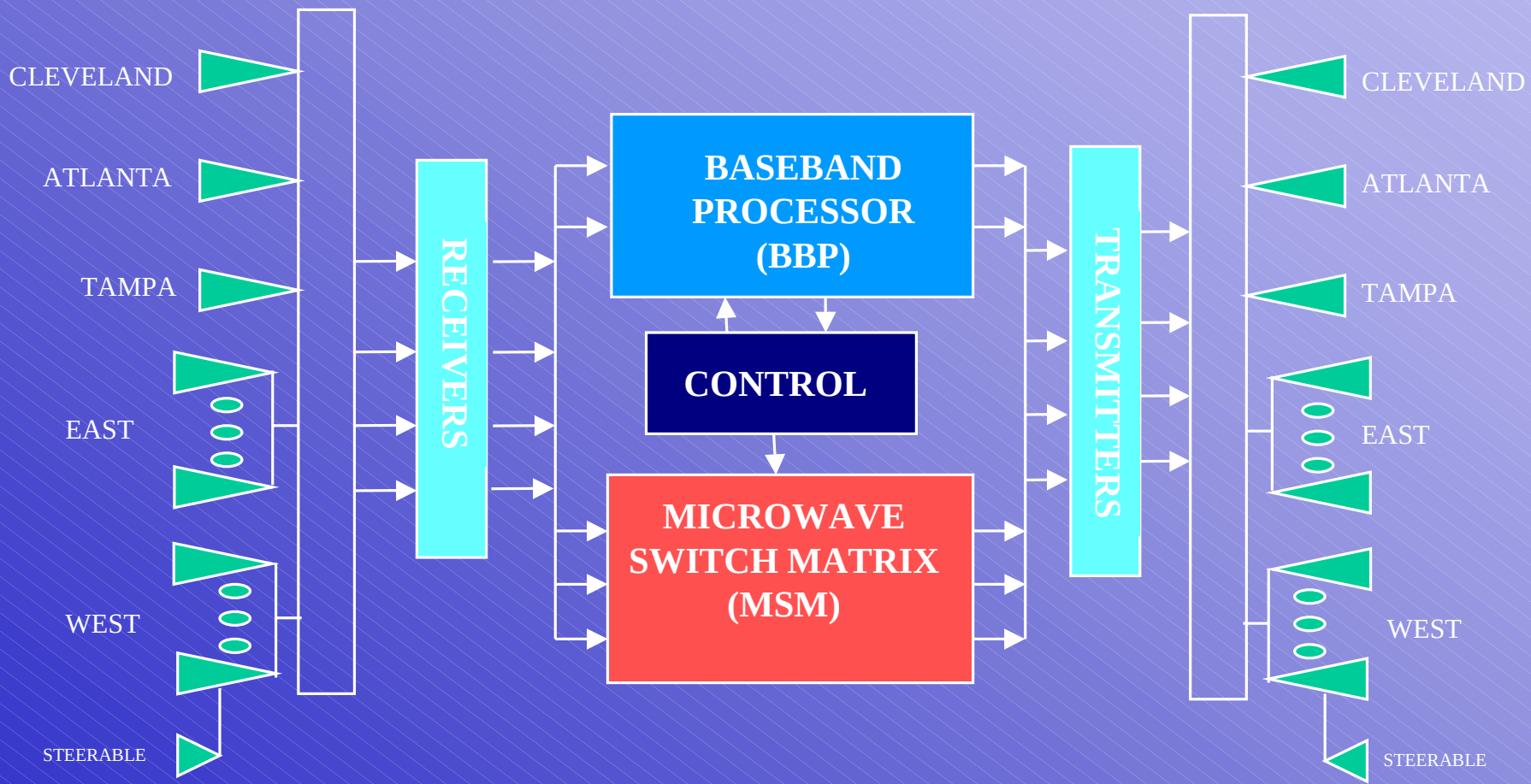
ACTS Payload Diagram



ACTS Fade Analysis Beyond 2000

Dr. Roberto J. Acosta

Senior Researcher

NASA Glenn Research Center

R. Acosta@GRC.NASA.gov

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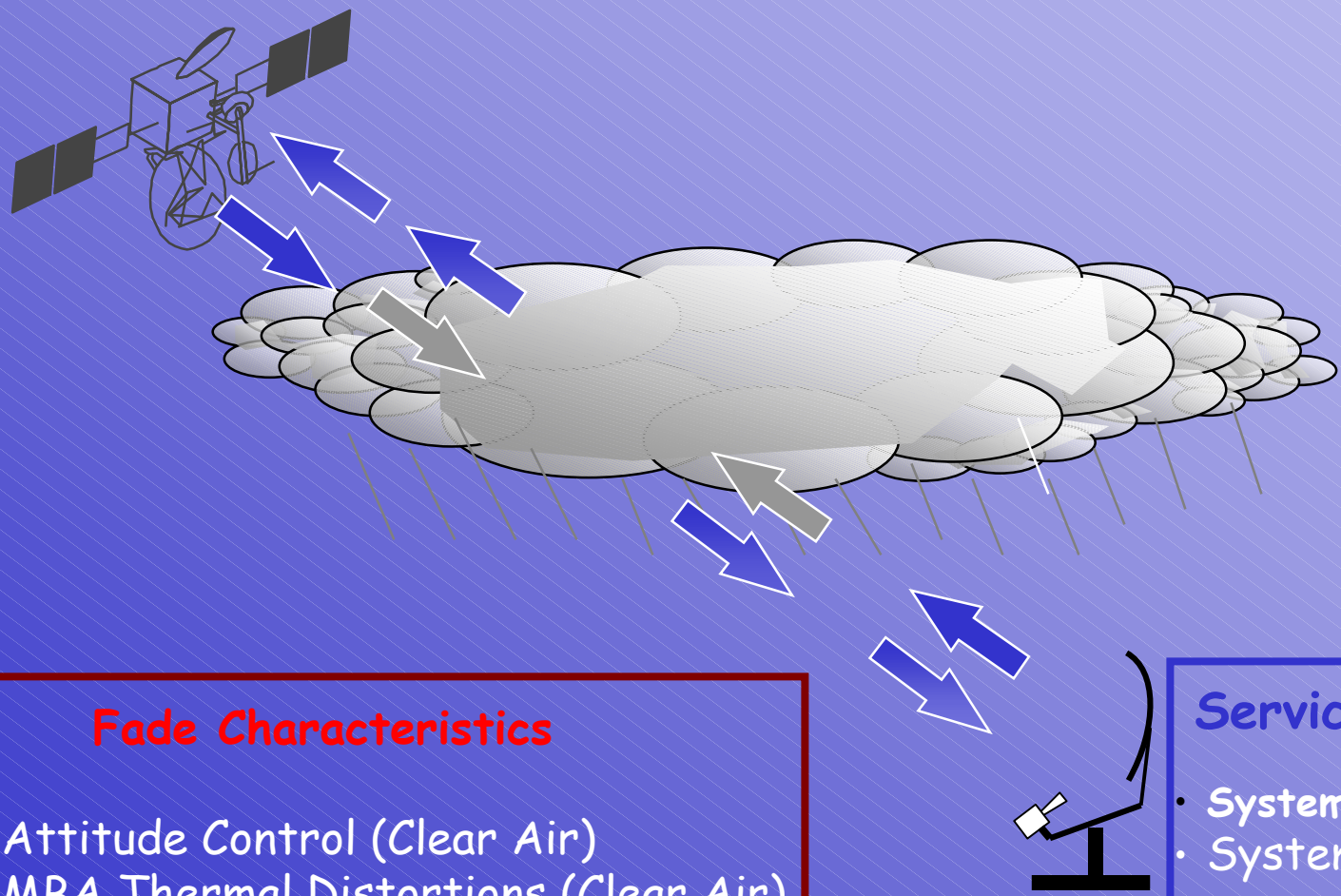
ACTS Fade Analysis Beyond 2000



Fade Characteristics

- Attitude Control (Clear Air)
- MBA Thermal Distortions (Clear Air)
- Rain Fade Attenuation

Service Quality

- System Margin
- System Availability

Ground Station

ACTS Fade Analysis Beyond 2000

Attitude Control Error Analysis

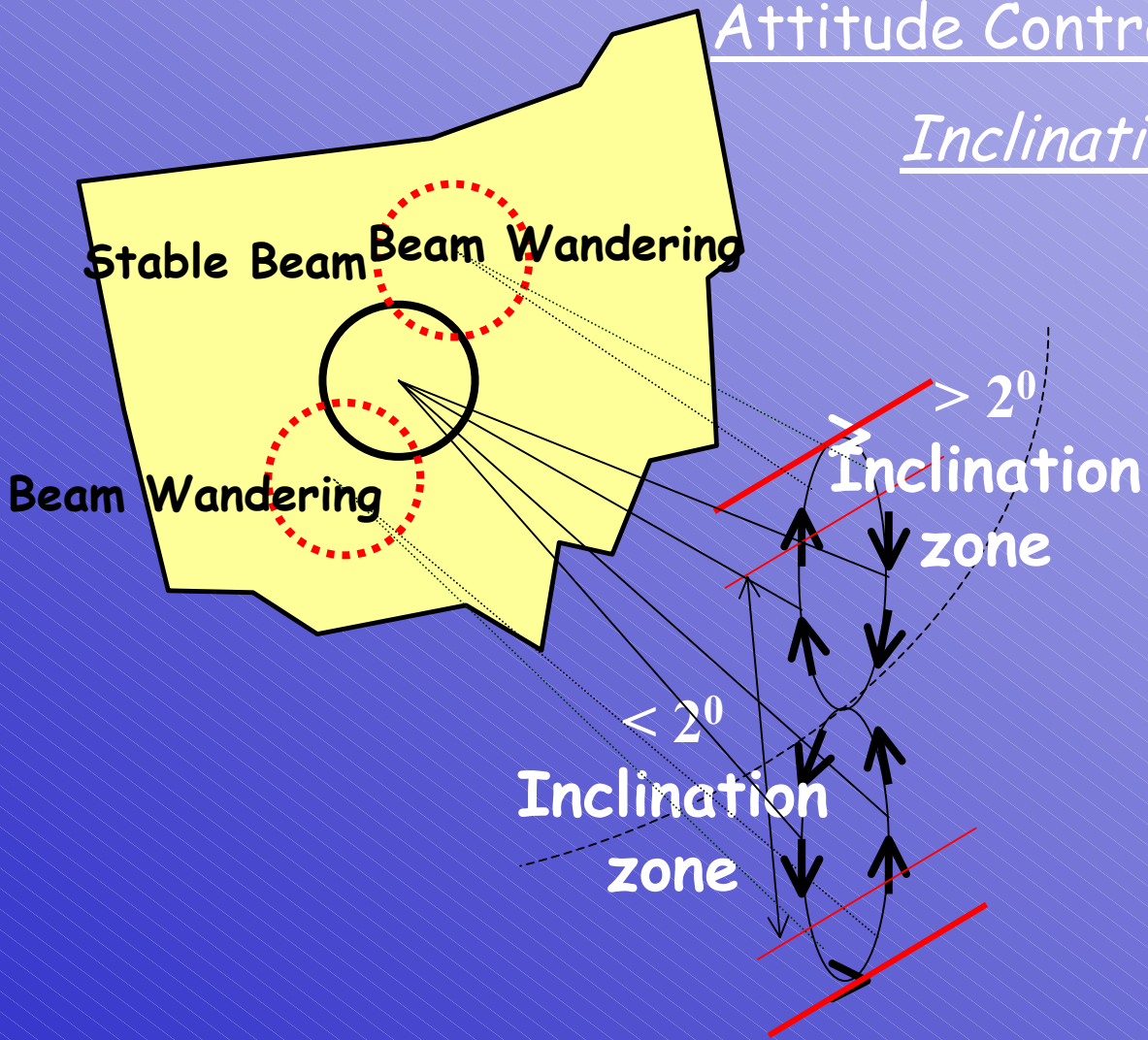
Earth Sensor

Pointing Error Magnitude		*MBA Fade*	*STEERABLE A Fade*
Roll (N-S)	+/- 0.1 ^{0}	< 2.3 dB	< 0.63 dB
Pitch (E-W)	+/- .05 ^{0}	< 1.1 dB	< 0.32 dB
RSS		max 2.6 dB	max 0.71 dB

ACTS Fade Analysis Beyond 2000

Attitude Control Error Analysis

Inclination Control



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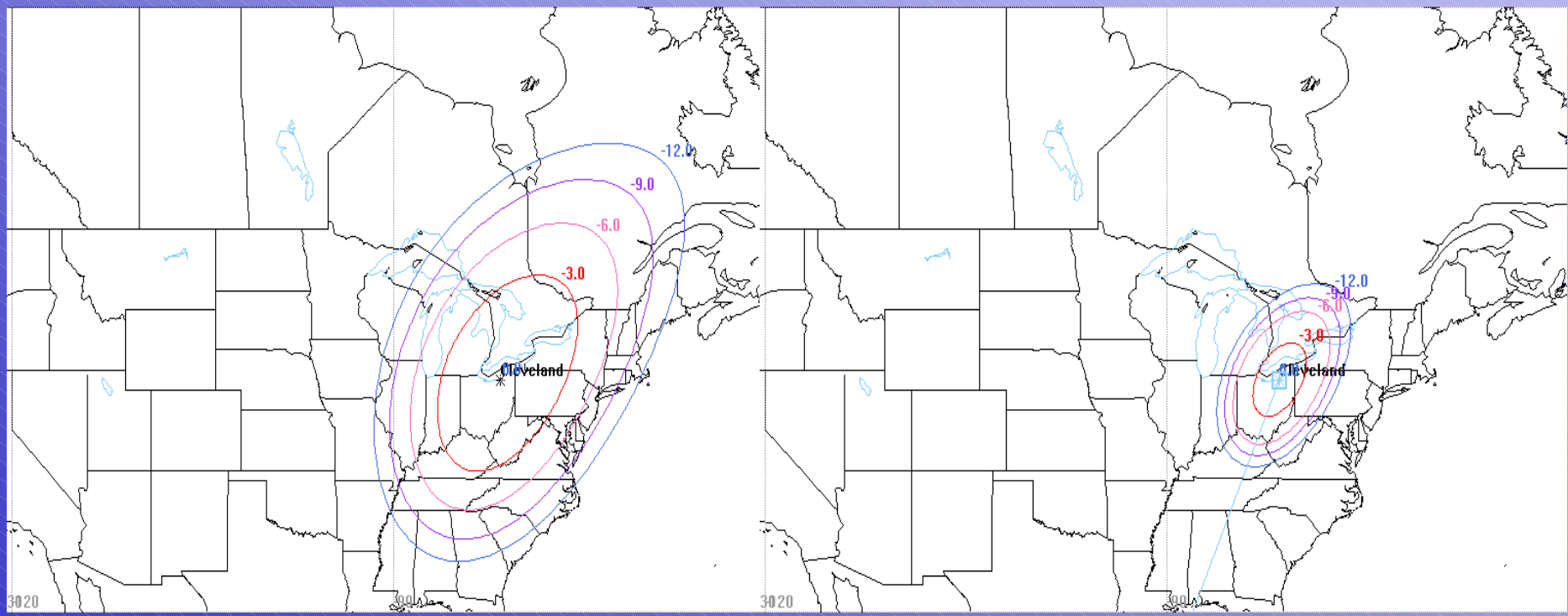
ACTS Fade Analysis Beyond 2000



Steerable Antenna

Dia = 1.1 m

HPBW = 0.95 Degrees (450 miles)

Multibeam Antenna

Dia = 3.3 m

HPBW = 0.3 degrees (150 miles)

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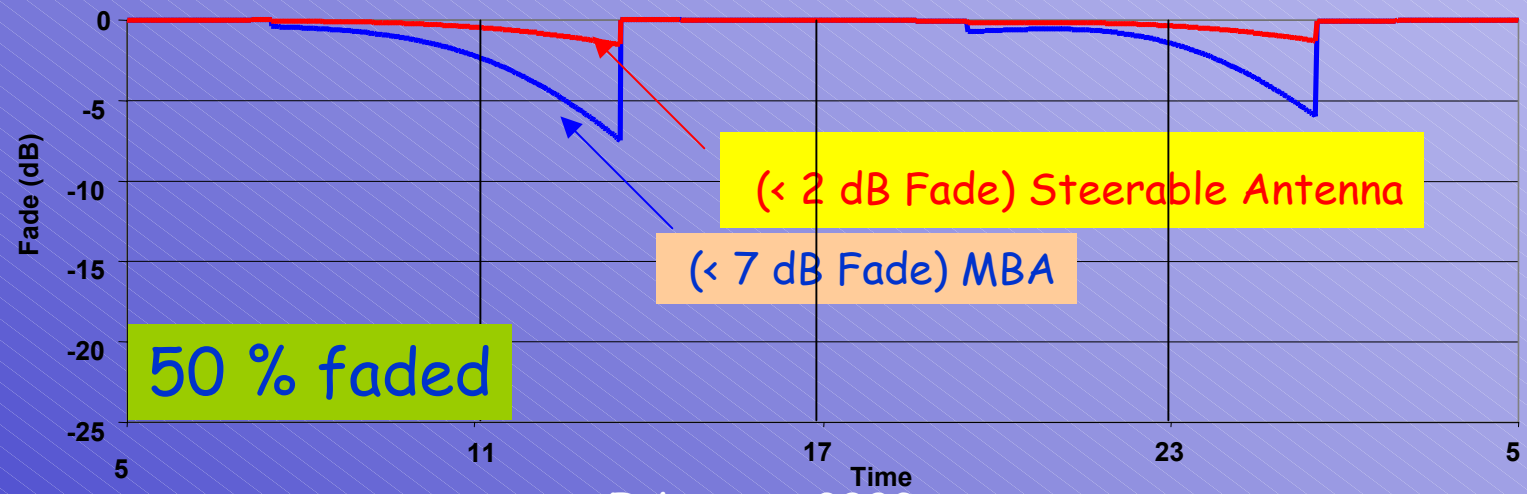
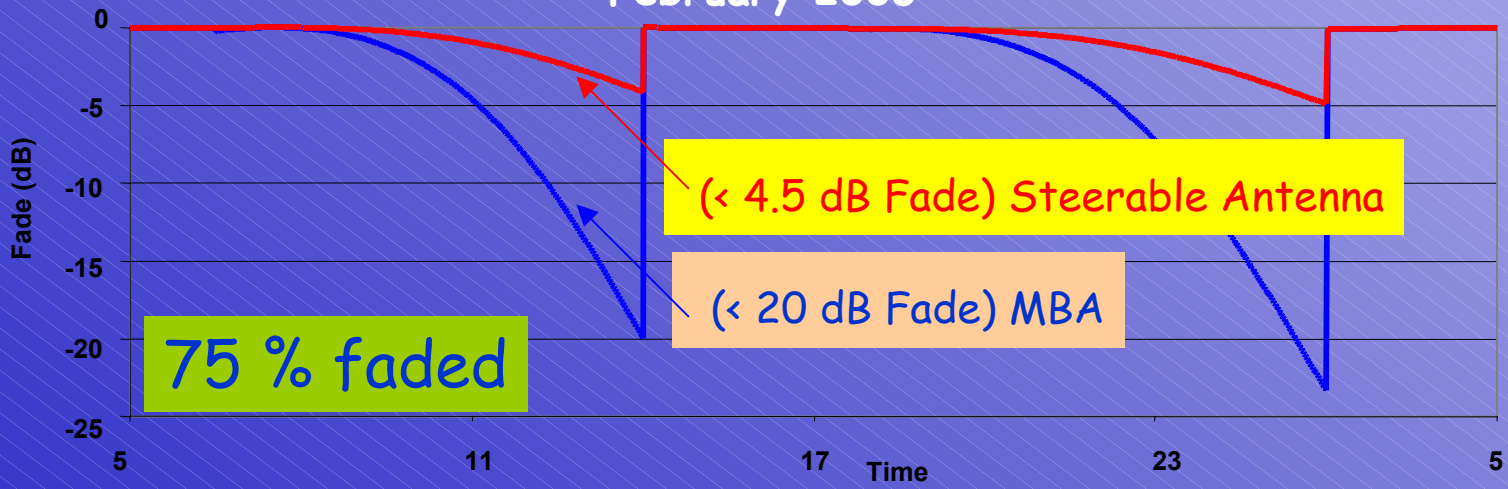
ACTS Fade Analysis Beyond 2000

February 2002 (*Inclination Exceeds 2 degrees*)



February 2003



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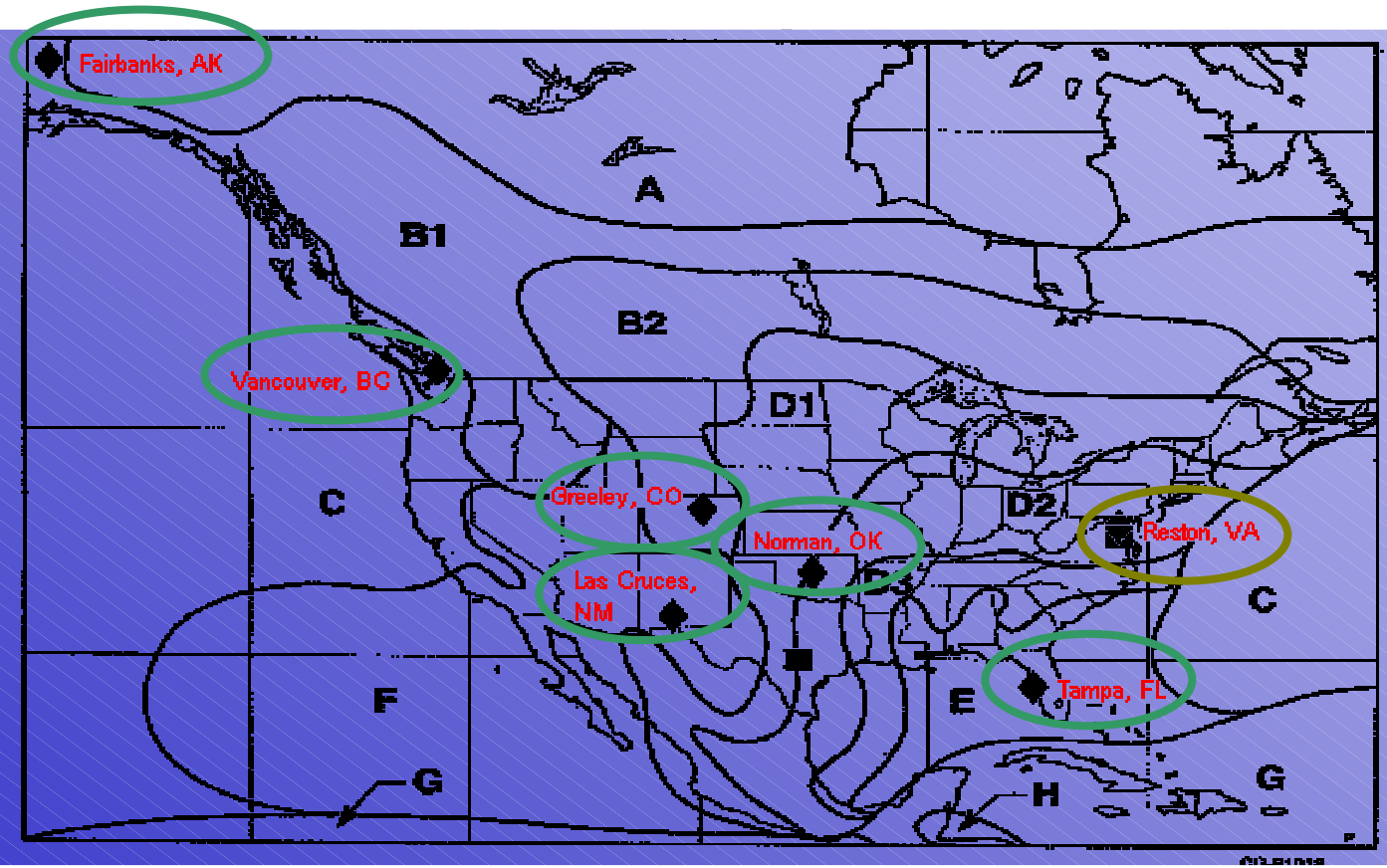
ACTS Fade Analysis Beyond 2000

Ka Band Measurements Sites



20 GHz and 30 GHz - 35 Station Years

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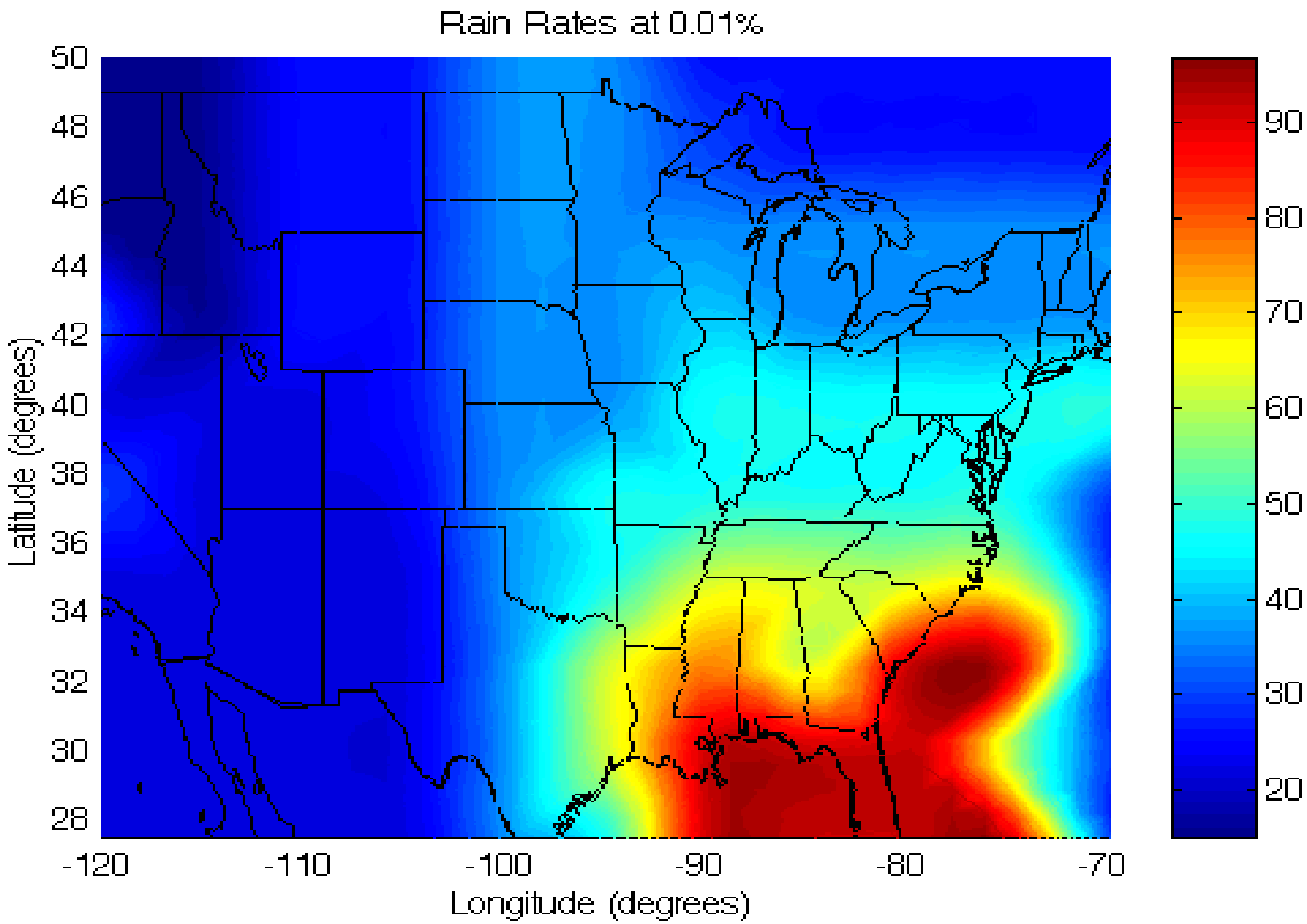
ACTS Fade Analysis Beyond 2000



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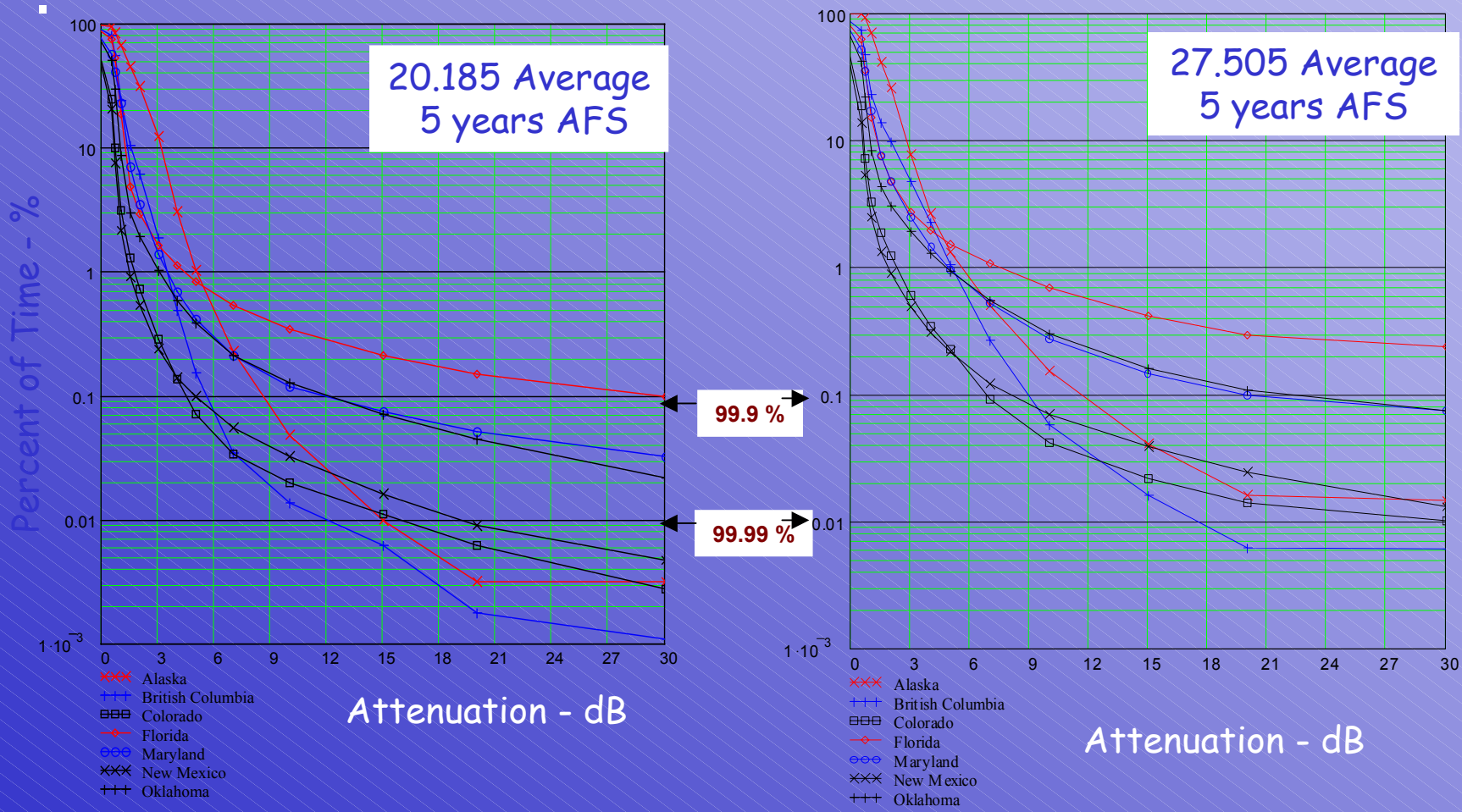
ACTS Fade Analysis Beyond 2000



ACTS Extension Workshop 10/24/00

Ohio Consortium for Advanced Communication Technology

Dennis Irwin, PhD, PE

Ohio University

Athens, OH

740.593.1566

Irwin@homer.ece.ohiou.edu

http://www.csm.ohiou.edu/OCACT/

Agenda

- Background
- Consortium Structure
- Costs
- Immediate Plans
- Discussion
- Expression of Interest

“History”

- **Initial Contact Via Ohio Aerospace Institute**
  - Early August 2000
  - Ohio University Meets with NASA GRC
- **Ohio University Organized Meeting of Ohio Institutions**
  - Late August 2000
  - Outcomes Included:
    - Assessment of Strong University Interest
    - Strategy to Secure Financial Commitments
    - Strategy to Obtain Ohio Board of Regents Support
    - National Workshop

Why an *Ohio* Consortium?

- Initial Strong Interest By Ohio Institutions
- Concentration of Experimentalists
- Initial Commitment By The *OhioView* Consortium
- Letter of Intent To NASA GRC Director From Chancellor of the Ohio Board of Regents
  - Instrumental in Postponement of ACTS Retirement

Consortium Structure

- Tiered Membership
  - Based on Financial Commitment, Type of Entity, and Date of Entry
    - Charter
    - Principal
    - Federal Agency
    - Corporate
    - Associate
    - Supporting

Consortium Structure

- Administrator
- Executive Council
  - Charter, Principal, and Corporate Members
  - Strategy, Membership, Liaison, Termination
- Steering Committee
  - Charter, Principal, Corporate, Federal Agency, and Associate Members
  - Plans and Monitors Resource Allocation, Requests Proposals, Formulates and Oversees Annual Plan

Consortium Structure

- Project Leads and Technical/Educational Teams
  - Project Implementation

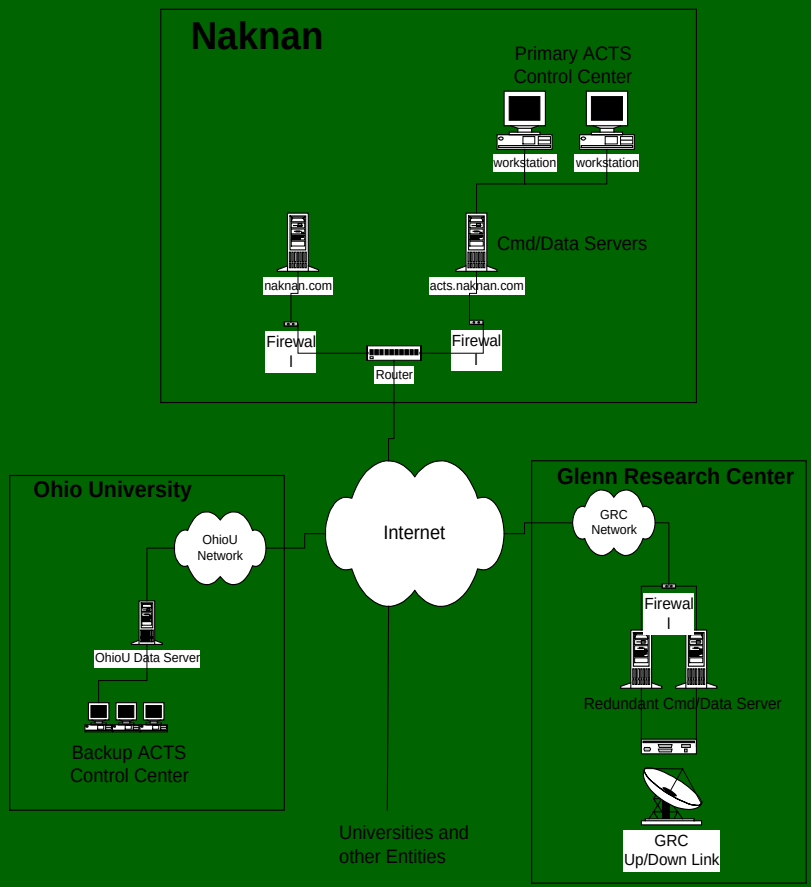
Costs

- Operational Costs
  - Estimated at $50k to $70k per month
  - Based on Continuing Existing Support Contracts
- Administrative Costs
  - Administrator
  - Office Support
  - $100k to $150k per year

Costs

- Alternatives Are Possible

ACTS Architecture
Deployment View



Immediate Plans

- Advertise Intent to Form the Consortium
  - *Space News, Commerce Business Daily*
  - Immediately
- Obtain Letters of Intent to Participate
  - Critical to Continuing Operations
  - December 1
- Form Consortium as Legal Entity
  - Need Ability to Enter Contracts
  - Early January 2001

Immediate Plans

- Informal Working Groups
  - Administrative Operational Structure
  - Fee Structure
    - Role of “in-kind” Contributions
    - Graduated Based on Membership Category
  - Usage Allowances and Limitations
    - Based on Membership Category
    - Commercial Usage Issues

Immediate Plans

- Informal Working Groups
  - Technical Operations Structure
    - Re-negotiate with Current Contractors?
    - Member Operated?
    - New Contractors?
- Discussion…