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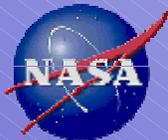
ACTS Extension Workshop 10/24/00



ACTS MASTER GROUND STATION OVERVIEW

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Revised November 1, 2000



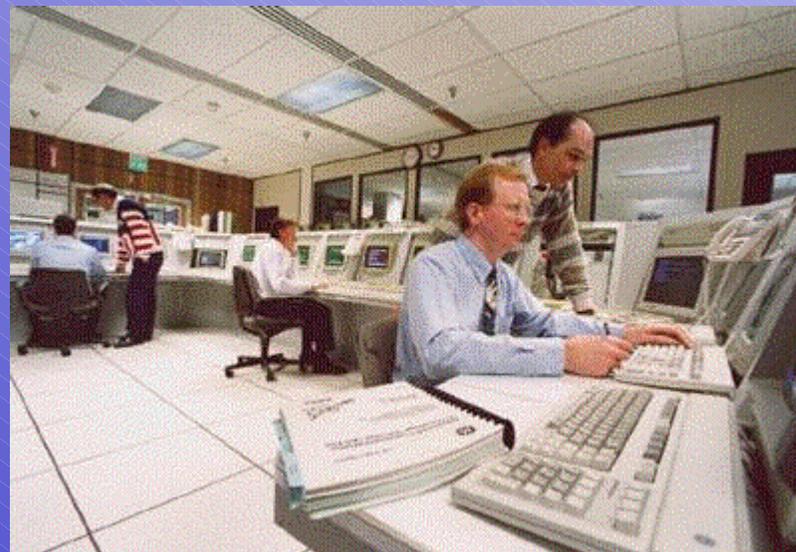
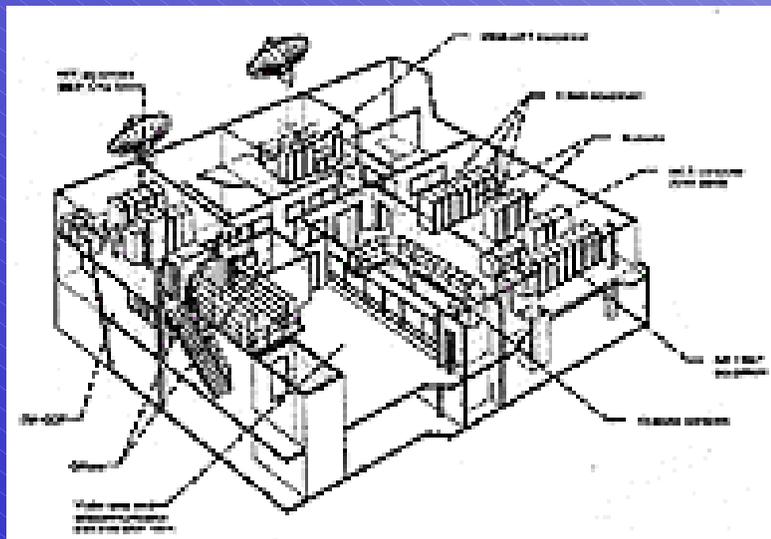
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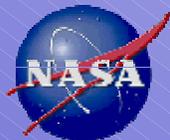
NASA ACTS Master Ground Station



ACTS Program

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





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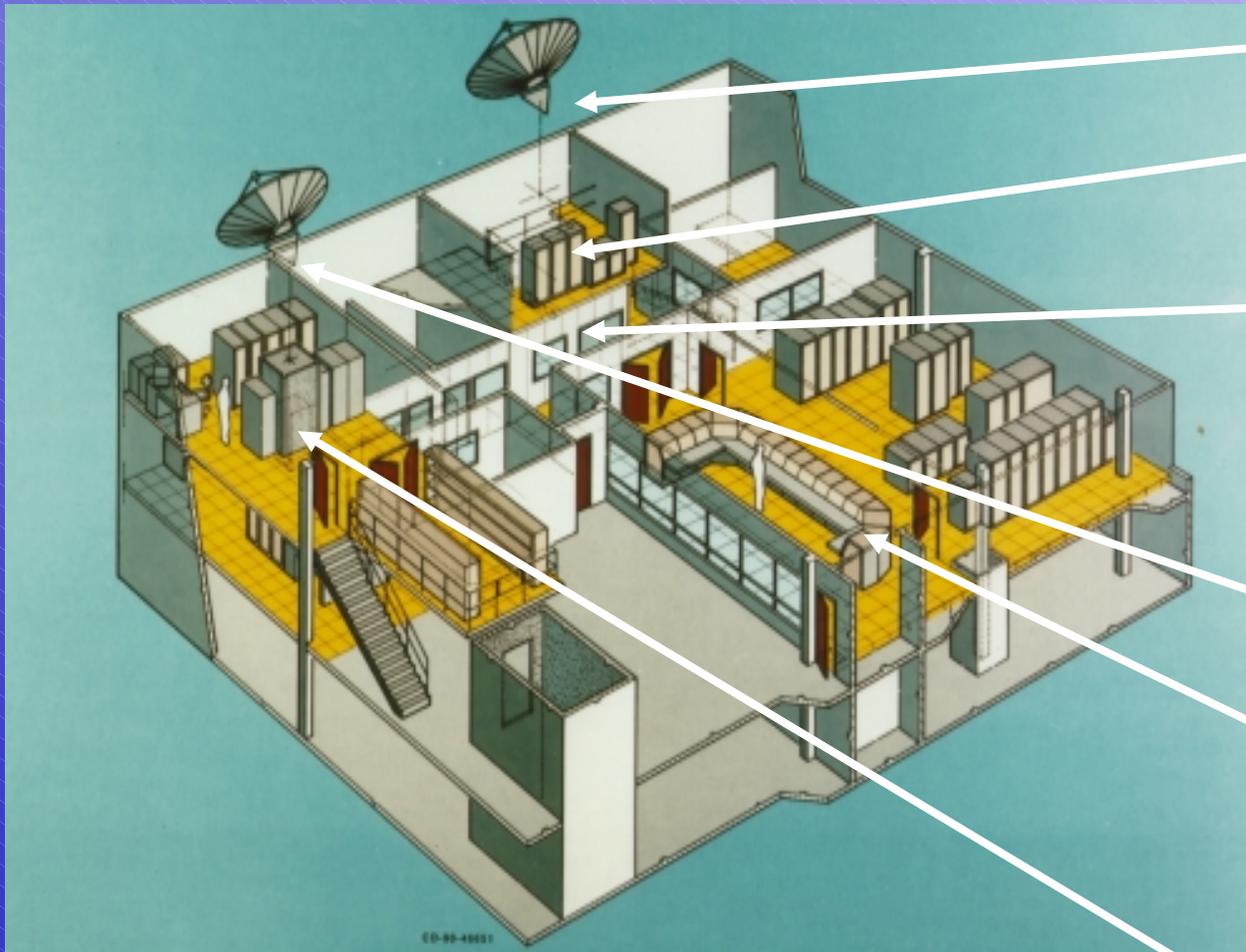
ACTS Master Ground Station





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ACTS Master Ground Station



LET Antenna

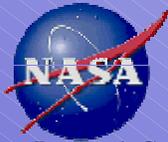
LET - Instrument Racks

LET Control Room

NGS Antenna

ACTS Control Console

NGS Instrument Racks



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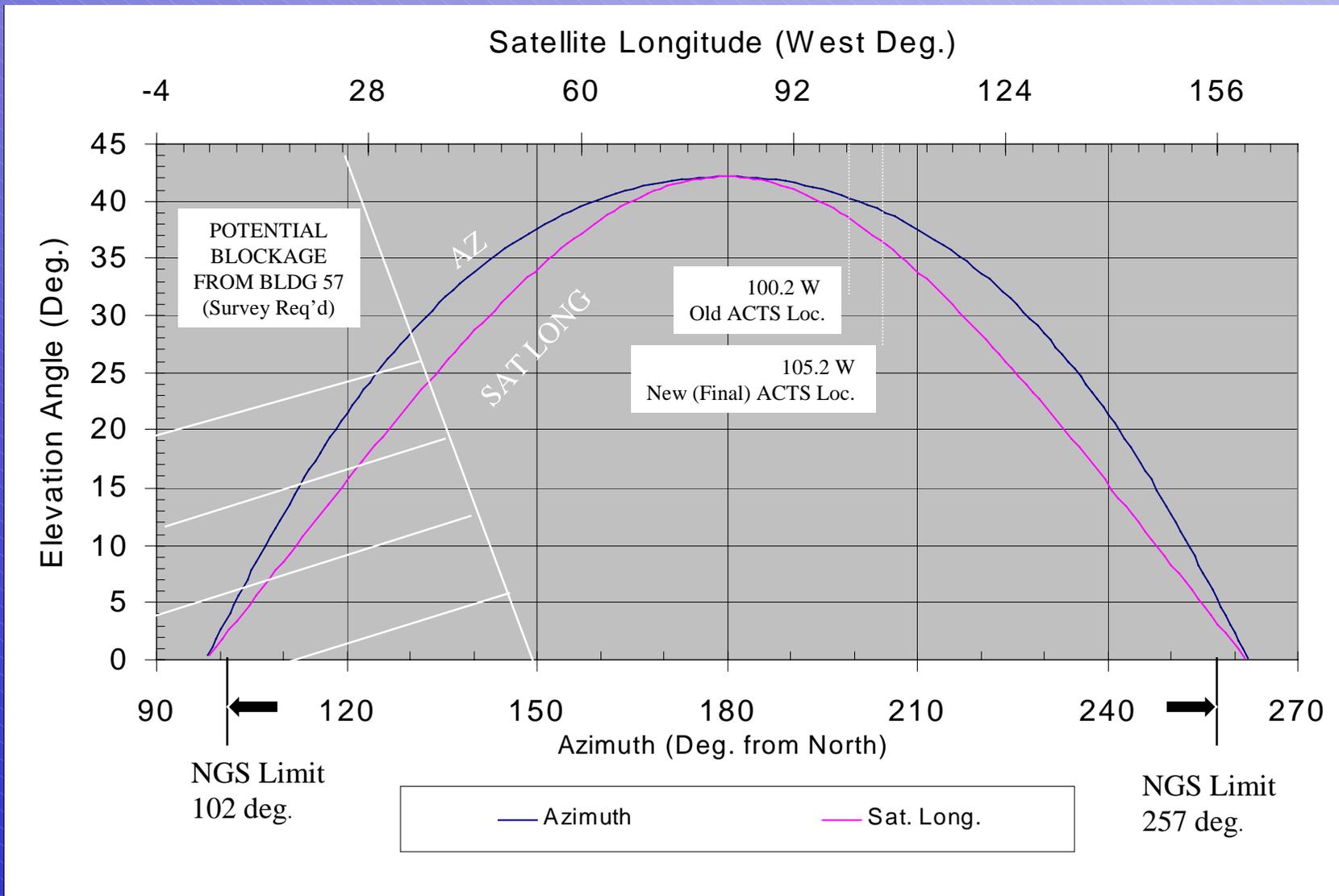


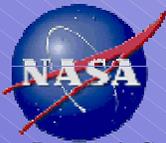
Current MGS Facility:

- 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



Geosynchronous Arc from GRC





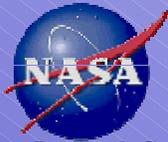
ACTS Master Ground Station



- 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
 - Corrugated 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

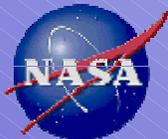


ACTS Master Ground Station



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



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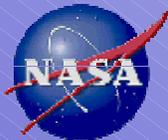
ACTS Master Ground Station



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



ACTS Master Ground Station



MGS SYSTEM PERFORMANCE

• <u>NGS Antenna</u>		<u>30 GHz</u>	<u>20 GHz</u>
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

• <u>Noise Performance</u>	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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MGS SYSTEM PERFORMANCE (continued)

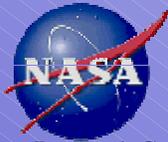
- Link Margins in ACTS Operations

• 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

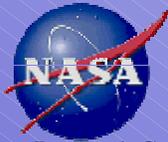


ACTS Master Ground Station



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

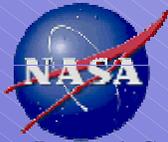


Support of Post-ACTS Missions:

- 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