

Reusable Reentry Satellite (RRS) Summary Report

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Telemetry, Tracking & Command (TT&C) Coverage Tradeoff Study

February 1991

Contract NAS9-18202
DRL 02

Prepared for:

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas 77058

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Science Applications International Corporation
An Employee Owned Company
21151 Western Avenue • Torrance, California 90501 • (213) 781-9022

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FOREWORD

The Reusable Reentry Satellite (RRS) Telemetry, Tracking & Command (TT&C) Coverage Tradeoff Study described herein was performed during Part 1 of the RRS Phase B contract. This report is one of several that describes the results of various trade studies performed to arrive at a recommended design for the RRS satellite system. The overall RRS Phase B Study objective is to design a relatively inexpensive satellite to access space for extended periods of time, with eventual recovery of experiments on Earth. The RRS will be capable of: 1) being launched by a variety of expendable launch vehicles, 2) operating in low earth orbit as a free flying unmanned laboratory, and 3) executing an independent atmospheric reentry and soft landing. The RRS will be designed to be refurbished and reused up to three times a year for a period of 10 years. The expected principal use for such a system is research on the effects of variable gravity (0-1.5 g) and radiation on small animals, plants, lower life forms, tissue samples, and materials processes.

This Summary Report provides a description of the RRS Telemetry, Tracking & Command Analysis performed to investigate the ground station coverage available to meet RRS requirements. Concepts were considered that used off-the-shelf technology, had generous margins of capability, had high reliability, were easily maintained, cost effective, and were compatible with existing support networks. From this study, a recommended RRS TT&C configuration will be developed.

The study was performed under the contract technical direction of Mr. Robert Curtis, SAIC Program Manager. The Telemetry, Tracking & Command analysis was led by Mr. Thomas Stuart of SAIC-Houston. Mr. Michael Richardson, JSC New Initiatives Office, provided the RRS objectives and policy guidance for the performance of these tasks under the NAS 9-18202 contract.

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List of Abbreviations and Acronyms

AFSCN	Air Force Satellite Control Network
BDA	Bermuda Tracking and Communications Site
CMOS	Complementary Metal Oxide Semiconductor
DoD	Department of Defense
DRM	Design Reference Mission
DSN	Deep Space Network
EPROM	Electronic Programmable Read Only Memory
GN	Ground Network
GSCF	Goddard Space Flight Center
GSTDN	Goddard Space Tracking and Data Network
IUS	Inertial Upper Stage
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
LNA	Low-Noise Amplifier
MA	Multi-Access
MILA	Merritt Island Launch Area
NASA	National Aeronautics and Space Administration
NGT	NASA Ground Terminal
OSN	Orbital Space Network
PCM	Pulse Code Modulation
PDL	Ponce de Leon
PM	Payload Module
RRS	Reusable Reentry Satellite
SAIC	Science Applications International Corporation
STDN	Space Tracking and Data Network
TDRS	Tracking and Data Relay Satellite
TDRSS	Tracking and Data Relay Satellite System
TT&C	Telemetry, Tracking, and Command
VAFB	Vandenberg Air Force Base

Executive Summary

The Telemetry, Tracking & Command (TT&C) Coverage trade study was performed to determine the ground coverage available to meet RRS communications and data handling requirements. The communications subsystem is required to provide a capability for the spacecraft and experiment operators to interface with the vehicle and experiments during all phases of the mission which is cost effective and compatible to existing communications support networks. The system design goals include limited use of TDRSS to provide critical operation visibility if no ground coverage is available.

The TT&C Coverage trade study was divided into two parts:

- 1) The first part of the study addressed both National Aeronautics and Space Administration (NASA) and non-NASA (i.e., Department of Defense) ground stations that have the required support capability and will be available over the RRS 10-year operational life time i.e, 1992 - 2002. These included the NASA ground stations, Air Force Space Control Network (AFSCN) ground stations, and Tracking and Data Relay Satellite System (TDRSS).
- 2) The second part examined the impact orbital parameters have on the RRS TT&C subsystems, and combined with the output of Part 1; determined which communication stations/systems could provide, as a minimum, two contacts per day.

Based on site coverage and hardware maturity/availability, SAIC recommends that the TDRSS and its associated ground network be utilized to support critical (e.g., reentry operations) RRS functions.

1.0 INTRODUCTION

1.1 Background

As currently conceived, the Reusable Reentry Satellite (RRS) will be designed to provide investigators, in several biological disciplines with a relatively inexpensive method of access to space for up to 60 days with eventual recovery on Earth. The RRS will be designed to permit totally intact, relatively soft, recovery of the vehicle, system refurbishment, and reflight with new and varied payloads. The RRS system will be capable of three reflights per year over a 10-year program lifetime. The RRS vehicle will have a large and readily accessible volume near the vehicle center of gravity for the Payload Module (PM) containing the experiment hardware. The vehicle is configured to permit the experimenter late access to the PM prior to launch and rapid access following recovery.

The RRS will operate as a free-flying spacecraft in orbit and be allowed to drift in attitude to provide an acceleration environment of less than 10^{-5} g's. The acceleration environment during orbital trim maneuvers will be less than 10^{-3} g's. The RRS is also configured to spin at controlled rates to provide an artificial gravity of up to 1.5 Earth g. The RRS system will be designed to be rugged, easily maintained, and economically refurbishable for the next flight. Some systems may be designed to be replaced rather than refurbished if cost effective and capable of meeting the specified turnaround time. The minimum time between recovery and reflight will be approximately 60 days. The PMs will be designed to be relatively autonomous with experiments that require few commands and limited telemetry. Mass storage if needed will be accommodated in the PM. The hardware development and implementation phase is expected to start in 1991 with a first launch in 1993.

Numerous trade studies and RRS functional design descriptions are required to define an RRS concept that satisfies the requirements and is viable. The NASA has contracted with Science Applications International Corporation (SAIC) to perform a Phase B study to provide the RRS concept definition. The TT&C analysis described in this report is one of the supporting study analysis performed by the SAIC team.

1.2 NASA JSC Statement of Work Task Definition

The TT&C analysis was performed per direction of the RRS Statement of Work and the System Requirements Document as given in the following paragraphs:

General:

RRS SOW Paragraph 3.1.2.6 - RRS Telemetry, Command, and Tracking System.
"Conduct tradeoffs related to ground communication link options for use during orbital operations:

- a) Examine various end-to-end RRS to ground communication links that may be available. Define the link capabilities and constraints. Consider both NASA and non-NASA ground stations location. Consider the availability of the possible communications link capabilities over the mission operational lifetime of 10 years. Data will be transmitted to and commands received directly from ground stations, rather than the Tracking and Data Relay Satellite System (TDRSS). This decision should be examined in greater detail during future system design studies.
- b) Examine approaches to accommodate the payload telemetry, command requirements, and tracking as a function of orbit type, and the number of telemetry/command contacts required per day.

1.3 Scope

This NASA Phase B study is intended to provide definition of the RRS concept. The study includes tradeoff studies with the depth of analysis as appropriate to clarify and document the viability of each approach. The RRS system and operations are developed to the degree necessary to provide a description of the designs and functional specifications. The RRS TT&C analysis was performed within this context.

2.0 STUDY APPROACH

2.1 Organization

The tradeoff analyses performed in Part 1 of the RRS Phase B study were organized to be accomplished in a series of related but separate tradeoff studies and system concept definitions. Therefore, the documentation described in these Summary Reports has been formatted to accommodate a compendium of analyses which are published in several separate documents. Because of the synergistic nature of one tradeoff study across the entire RRS system design, it is suggested that the reader review all Summary Reports in order to get a complete picture of the SAIC RRS design.

2.2 Document Format

Individual analyses and studies are not necessarily amenable to documentation in exactly the same topical arrangement, however a general outline has been used where reasonable for all reports. The guideline for preparing the individual study sections in this and all Summary Reports is provided below:

- Purpose
- Groundrules and Assumptions
- Analysis Methodology
- Analysis Results
- Conclusions
- Recommendations

3.0 PURPOSE

The purpose of these studies was to define the tracking coverage available to meet the needs of the RRS missions.

4.0 GROUND RULES AND ASSUMPTIONS

The analyses described in this report were performed using the RRS Design Reference Mission (DRM) set shown in Table 4-1. DRMs 1, 2 and 3 were used to calculate contact opportunities for NASA Ground Stations, the Air Force Space Control Network, and the TDRSS.

A general groundrule used in the TT&C Coverage trade study was that a single TT&C design should be capable of meeting all mission needs. In addition, it was assumed only proven hardware and software could be utilized in the design and that some ground-based support would be required. Omnidirectional coverage, with a minimum of two contacts per day, was also desired.

In addition to the general groundrules and assumptions, several design and operational features were desirable that were utilized to initialize the studies. These were:

- 8 to 12 Hour Separation Between Contacts
- Minimum 10 Minutes Each Contact
- Contacts in Continental United States
- Uplink Maximum 2 Kbps
- Downlink Maximum 32 Kbps
- Redundancy of Key Subsystems

Table 4-1 RRS Design Reference Mission Set Definition

Definition Parameter	Design Reference Mission Set				
	DRM-1	DRM-2	DRM-3	DRM-4	DRM-5
Character	Land Recovery	High Altitude	High Inclination	Integer Orbits	Water Recovery
Inclination	33.83°	33.83°	98°	35.65°	28.5°
Orbit Type	Circular	Circular	Circular, Near-Integer	Circular, Integer	Circular
Orbit Altitude	350 km (189 nm)	900 km (486 nm)	897 km (484 nm)	479 km (259 nm)	350 km (189 nm)
Launch Site	Eastern Test Range (ETR)	Eastern Test Range (ETR)	Western Test Range (WTR)	Eastern Test Range (ETR)	Eastern Test Range (ETR)
Recovery Site	White Sands Missile Range (WSMR)	White Sands Missile Range (WSMR)	White Sands Missile Range (WSMR)	White Sands Missile Range (WSMR)	Water (ETR, Gulf of Mexico, WTR)

5.0 ANALYSIS METHODOLOGY

The RRS communications subsystem is required to provide a capability for the spacecraft and experiment operators to interface with the vehicle and experiments during all phases of the mission. NASA's initial studies resulted in requirements to uplink vehicle and payload commands, and orbital tracking and vehicle/payload telemetry to be downlinked at least twice a day. System design goals are to utilize equipment which is simple, available, reliable, and affordable. Concepts that must be considered to meet these goals include use of off-the-shelf technology, generous margins of capability, high reliability, easily maintainable, operational cost effectiveness, and compatibility to existing communications support networks.

The TT&C Coverage trade studies were performed with the goal of identifying the best combination of onboard and ground support systems for the RRS application. The study was divided into three parts:

- 1) The first part of the study addressed both NASA and non-NASA (i.e., Department of Defense) ground stations that have the required support capability and will be available over the RRS 10-year operational lifetime i.e., 1992 - 2002.
- 2) The second part examined the impact orbital parameters have on the RRS TT&C subsystems, and combined with the output of Part 1; determined which communication stations/systems could provide, as a minimum, two contacts per day.

In order to begin the studies, the overall TT&C system requirements were postulated for telemetry, command, and tracking functions necessary to support operations in the post-1992 time period. The NASA ground stations, Air Force Space Control Network ground stations, and TDRSS capabilities planned to be available were determined. NASA and Department of Defense (DoD) engineers, vendors, and other sources were contacted to develop guidelines and requirements to provide initial TT&C definition data necessary to complete the studies.

6.0 ANALYSIS RESULTS

6.1 NASA/Non-NASA Ground Support Sites

In determining what ground support sites would be available to support the RRS in the 1992 to 2002 timeframe, conversations were initiated with the Space Tracking and Data Network organization at Goddard Space Flight Center (GSFC), the Deep Space Network organization at Jet Propulsion Laboratory, and the Air Force Space Network Division at the Air Force Space Test Center. In addition, the GSFC Space Network User Guide and the AF Space Test Range Handbook were referenced. From these discussions and inferences, the following information and results were developed.

The NASA Space Tracking and Data Network (STDN) consists of a Ground Network (GN) and a Space Network (SN). The GN is being phased down and by 1992 will consist of the Merritt Island Launch Area (MILA), Ponce de Leon (PDL), and Bermuda Tracking and Communication Sites (BDA). These sites will provide prelaunch, launch, and landing communications support for spacecraft and launch vehicles during the RRS era. Depending on schedules, these sites could provide some limited support to RRS, but could not be considered as prime orbital support sites on a continuous basis. The SN consists of two segments, the space segment and the ground segment. The space segment consists of two operational Tracking and Data Relay Satellites (TDRS) and a space TDRS in geostationary orbit. Each TDRS provides

functionally identical communications capability. Figure 6-1 shows the basic TDRS configuration available in 1990. The ground segment consists of: White Sands, New Mexico, which provides the communications capability for data transfer via the TDRS as well as the operations control for the TDRS itself; the NASA Ground Terminal (NGT) which provides the operational interface between the TDRSS and the NASCOM common carrier circuits; and the MILA and Vandenberg Air Force Base (VAFB) TDRSS relays, which provide a prelaunch, launch, and bonding support for the Space Transportation System and for user spacecraft payloads. Based on the above discussion, the only NASA STDN service available in 1992 and beyond would be the TDRSS.

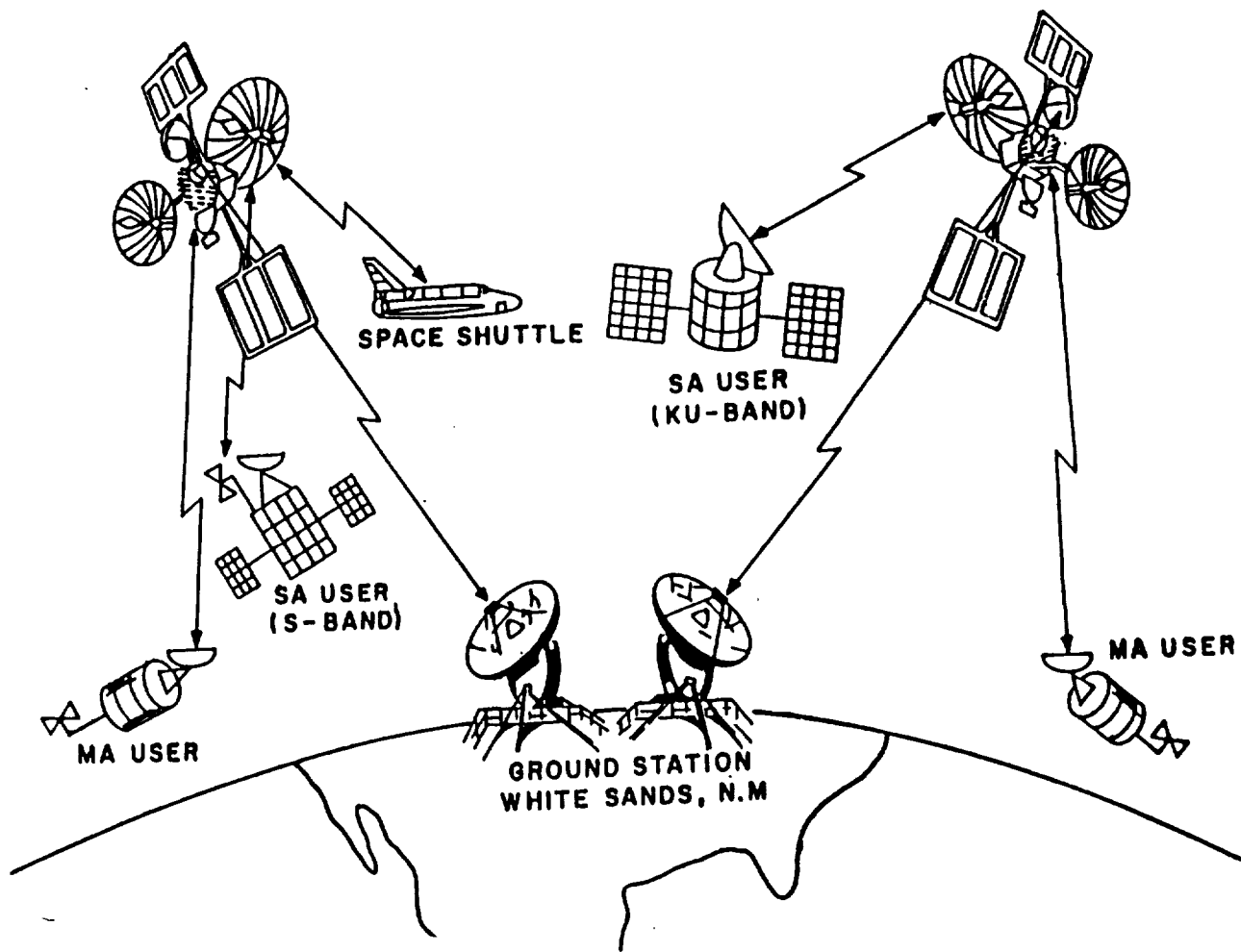


Figure 6-1. TDRSS/User Spacecraft Configuration

The Deep Space Network (DSN) consists of the Goldstone, California; Madrid, Spain; and the Canberra, Australia deep space communication sites. Controlled by the Jet Propulsion Laboratory (JPL), these sites are dual sites, i.e., one side provides only deep space support; the second side is the old SDTN sites which were turned over to JPL with the phase down of STDN. These sites provide telecommunications and tracking support during an Inertial Upper Stage (IUS)/TDRS deployment for the NSTS as well as transfer and on-orbit operations during initial checkout and verification phases of the TDRS mission. In addition, the Orbital Space Network (OSN) provides backup support to the DSN until the TDRSS becomes fully operational. The DSNs would be available for limited support during the 1992 to 2002 timeframe, however, they should not be considered for full time (60 days at a time) support to the operational RRS. Figure 6-2 depicts the NASA Space Network for 1992 and beyond.

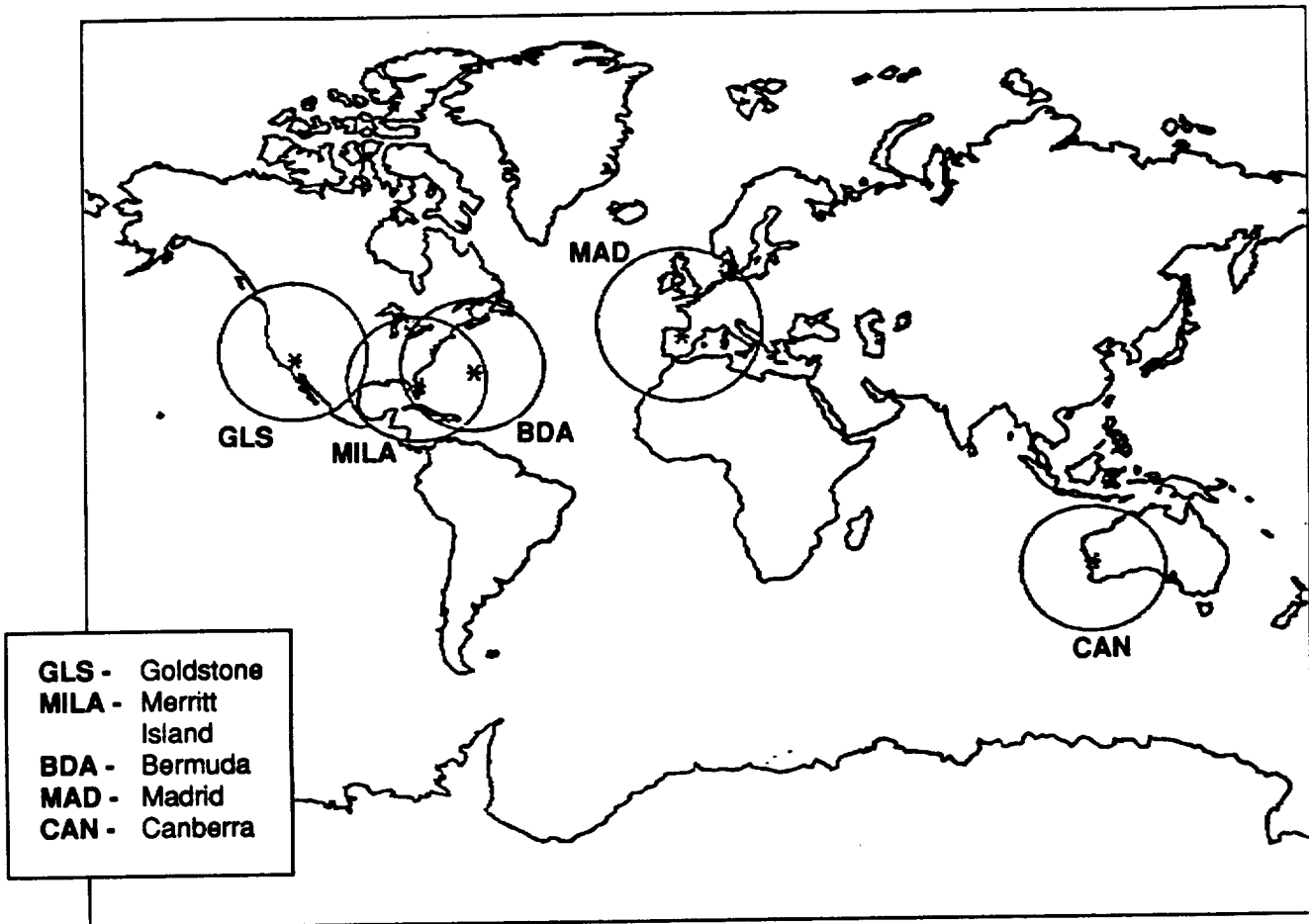


Figure 6-2. NASA Space Network (1992)

The ASFCN is a set of common user resources and facilities that collectively are used to provide telemetry, command, and tracking support for the DoD spacecraft plus limited NASA and foreign government space programs. An overview of the current AFSCN is shown in Figure 6-3. The ASFCN will consist of nine (9) sites in the 1992 and beyond timeframe. Six of the sites are dual sites and three are single sites. The dual sites have two antennae and associated equipments to allow multivehicle support at the site. These sites are located around the world and consist of the Vandenberg Tracking Station, New Hampshire Tracking Station, Thule Tracking Station, Guam Tracking Station, Hawaii Tracking Station, and the Telemetry and Command Station at Oakhanger, England. The single sites are the Indian Ocean Tracking Station, Colorado Tracking Station and the Diego Garcia Tracking Station. Figure 6-4 depicts the AFSCN from its current state to its projected state in year 2015. In addition to the remote tracking sites, the AFSCN has two control centers, the Satellite Test Center at Sunnyvale, California, and the Consolidate Space Operations Center at Colorado Springs, Colorado.

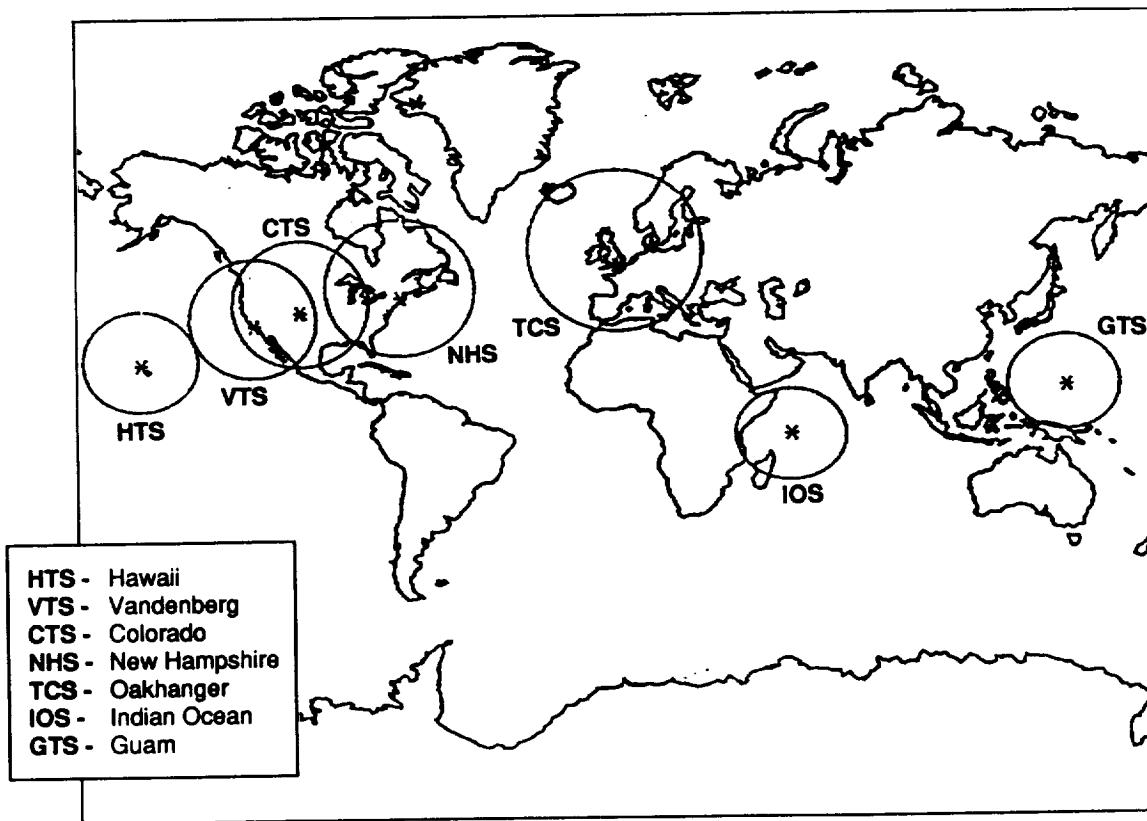


Figure 6-3. Air Force Space Network (1992)

The AFSCN can provide the RRS-to-ground interface for TT&C however, its prime function is support to the DoD satellite programs. The Air Force could provide limited/backup coverage but would not be available for full time (60 days at a time) support for an operational RRS.

6.2 Impact of Orbital Parameters

To determine the orbital parameters for the RRS the three design reference missions were plotted for the NASA Space Network, the TDRSS, and the AFSCN. Figure 6-5 shows the ground trace for DRM-1 350 km altitude and 33° inclination. As shown, the NASA network limits its coverage to the northern hemisphere. At this altitude and inclination, you can get two contacts per day; however, the contacts are less than 10 minutes each and come within 2 to 3 hours of each other. Figure 6-6 displays the DRM-2 configuration, 900 km altitude and 33° inclination. This gives basically the same coverage as for DRM-1; contact time does increase to about 10 minutes each. Figure 6-7 shows the ground track for DRM-3, 870 km altitude at 98° inclination. At this altitude and inclination, the NASA network can meet all of the communications requirements except continental U.S. coverage, i.e., two contact per day - 10 minutes coverage; and 10-12 hours separation of data takes. However, in order to get the separation, the Canberra tracking station would have to be utilized. The detailed contact histories for DRMs 1, 2 and 3 using the NASA Tracking Network appear in Appendix A for reference.

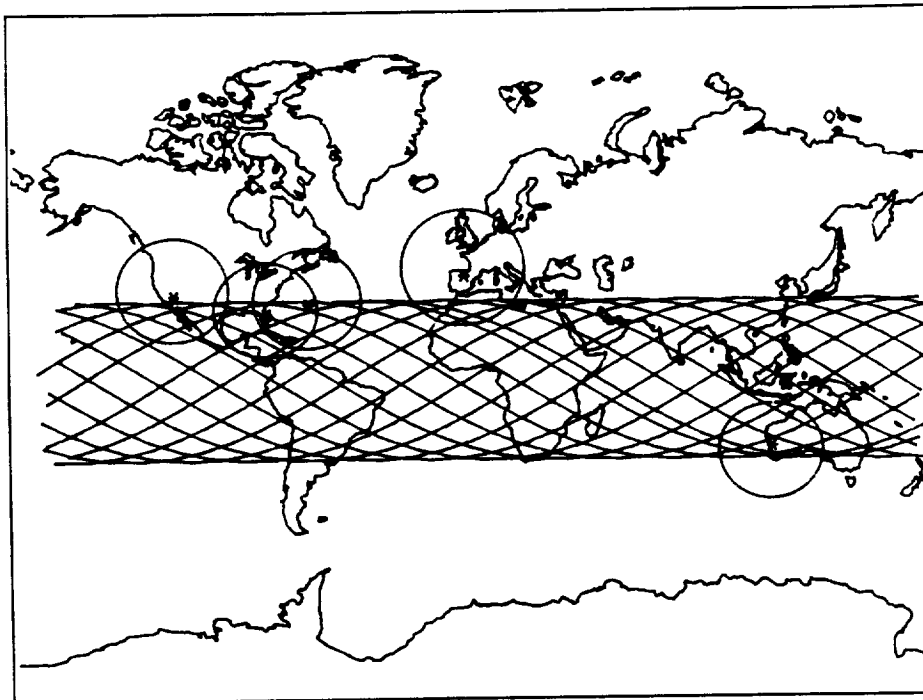


Figure 6-5. DRM-1 Ground Trace - NASA Space Network

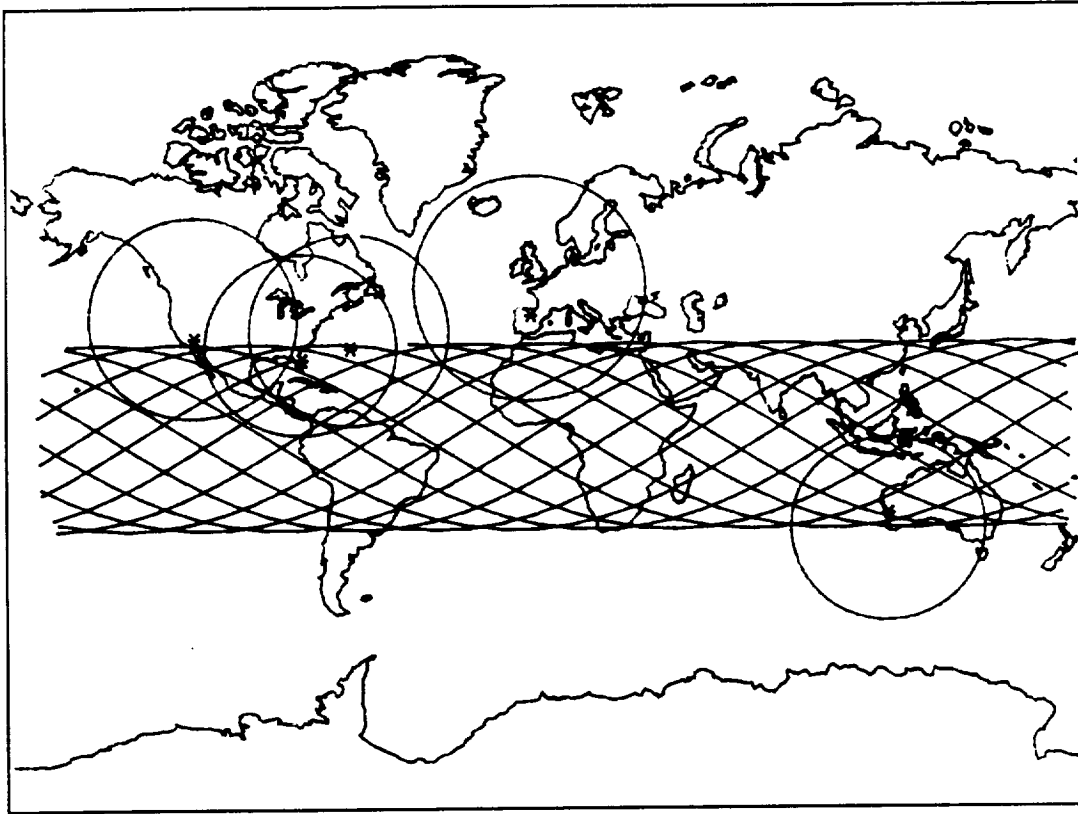


Figure 6-6. DRM-2 Ground Trace - NASA Space Network

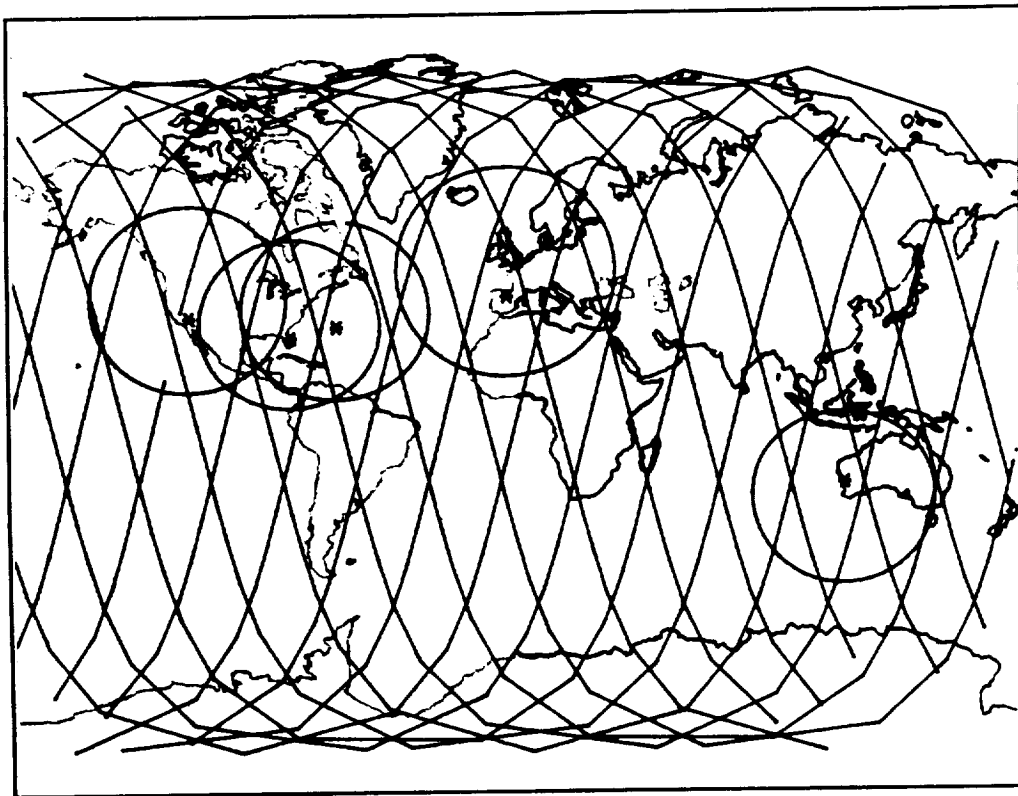


Figure 6-7. DRM-3 Ground Trace - NASA Space Network

The AFSCN orbital traces are depicted in Figures 6-8 through 6-10. These figures show the coverage for each of the design reference missions DRM-1, DRM-2, and DRM-3, respectively. In DRM-1, the coverage approximates the NASA networks coverage for DRM-1, however, you can get 10 - 12 hour separation utilizing foreign sites. DRM-2 will allow coverage for over 10 minutes, but you must use foreign sites for the separation. DRM-3 allows coverage as required and with judicious planning could provide continental U.S. site coverage. The detailed contact histories for DRMs 1, 2 and 3 using the Air Force Space Network appear in Appendix B for reference.

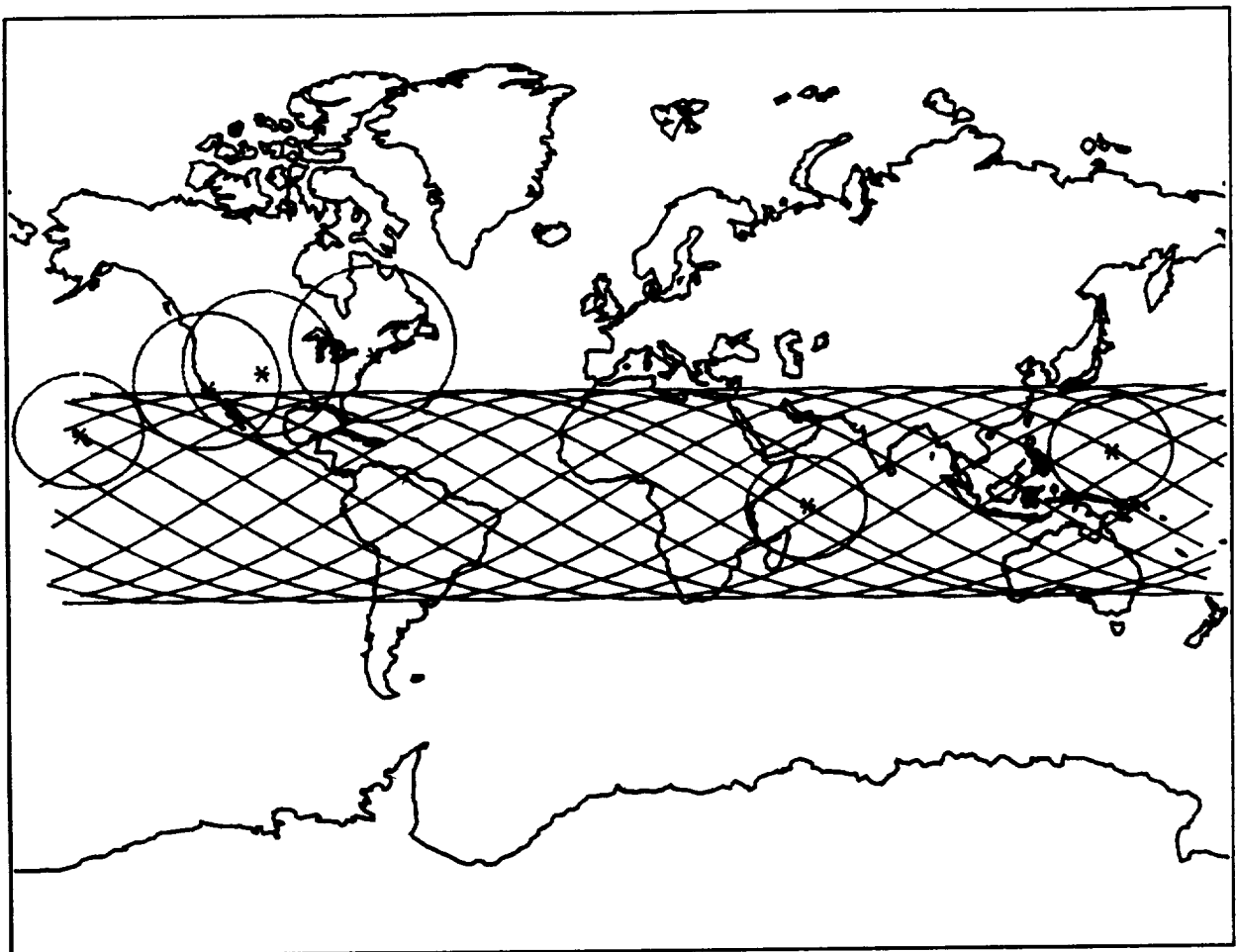


Figure 6-8. DRM-1 Ground Trace - Air Force Space Network

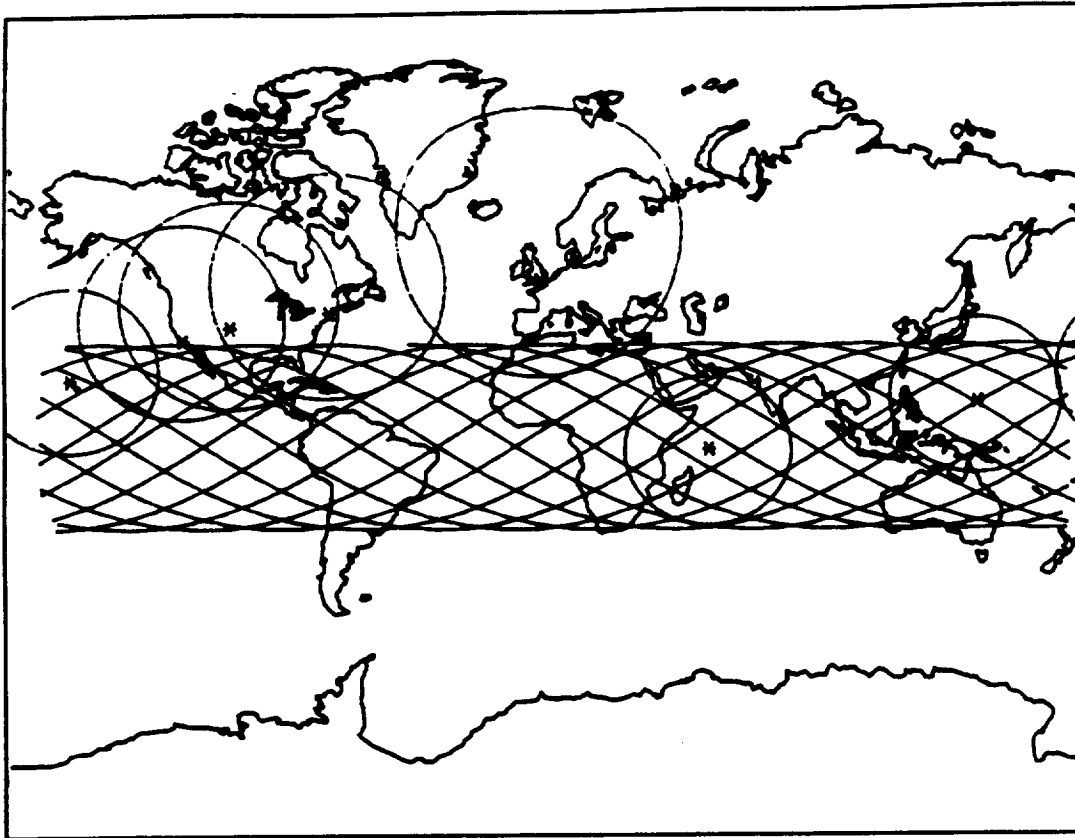


Figure 6-9. DRM-2 Ground Trace - Air Force Space Network

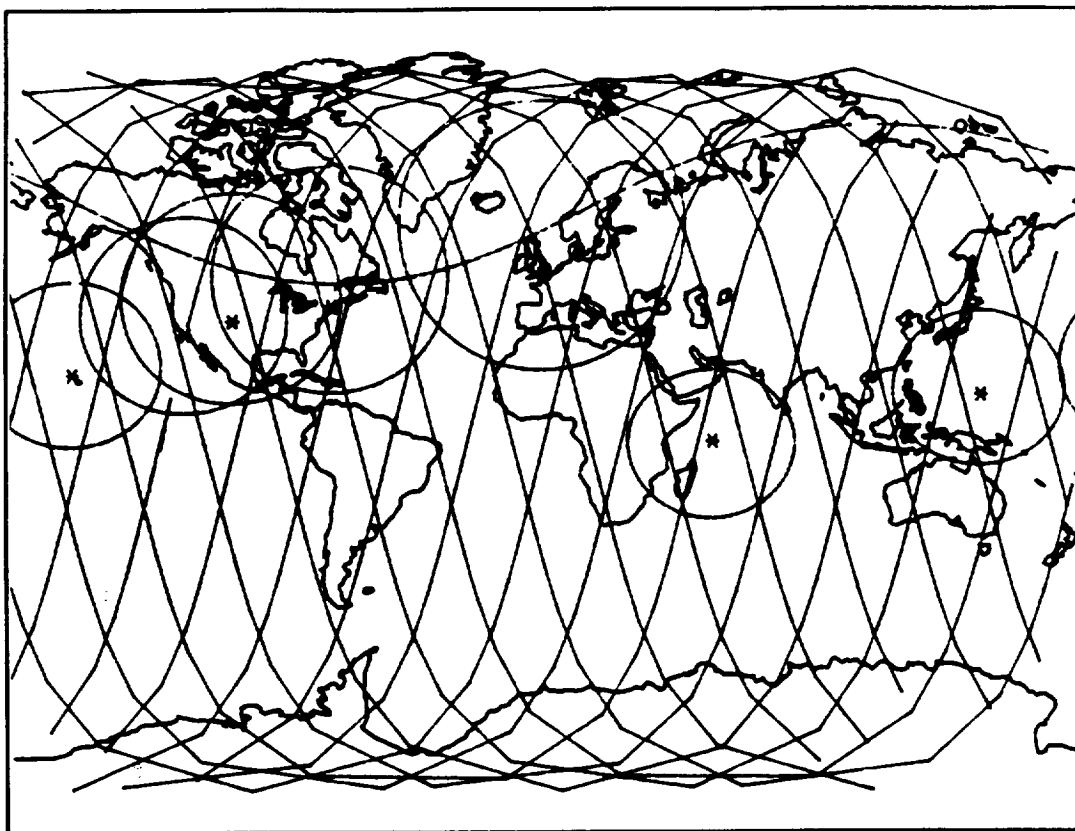


Figure 6-10. DRM-3 Ground Trace - Air Force Space Network

The TDRSS geometric coverage is summarized for DRMs 1, 2 and 3 in Figure 6-11. As shown, each of the design reference missions would have all requirements met, and even in cases where additional real-time support might be dictated, the support could be scheduled. The detailed contact histories for DRMs 1, 2 and 3 using TDRSS appear in Appendix C for reference.

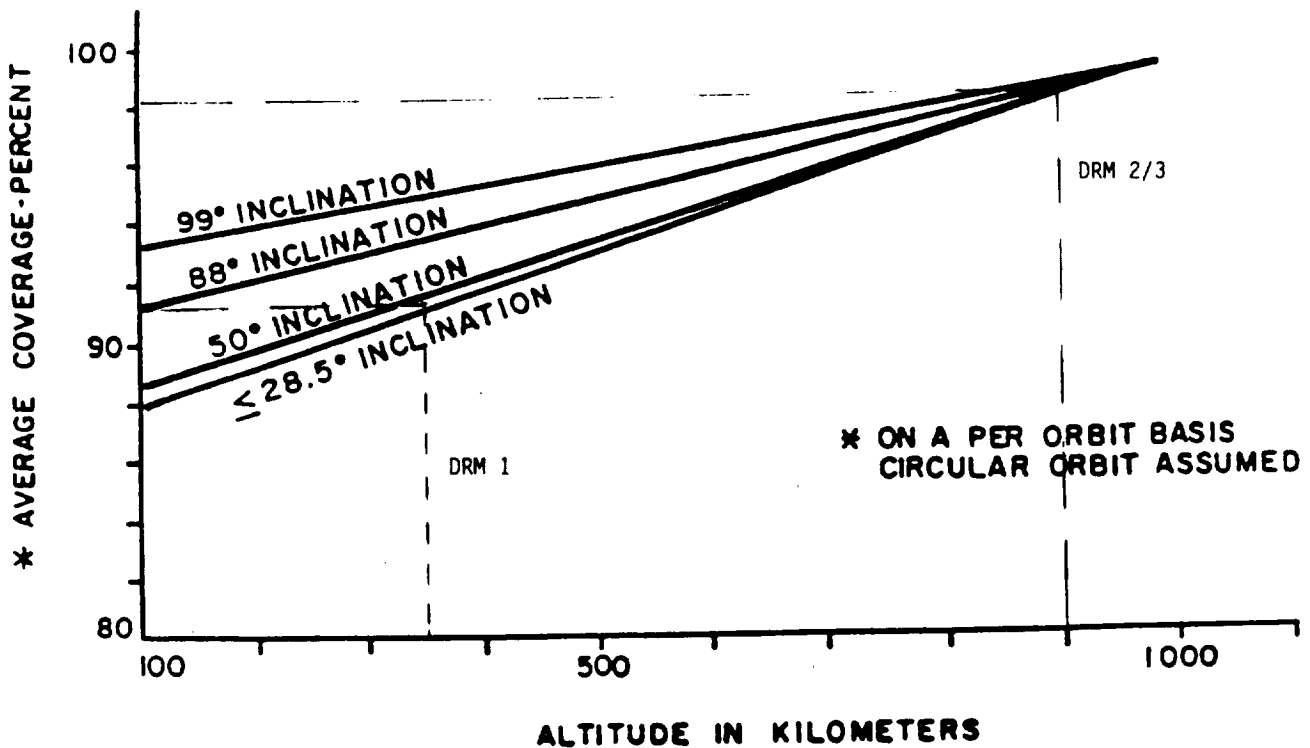


Figure 6-11. TDRSS Coverage vs. Altitude and Inclination

Tables 6-1 gives summarized tabulations of the contact histories for each of the networks discussed above. Based on the coverage tabulation and the ground traces, the best solution for RRS TT&C appears to be the use of the TDRSS to support the 10-year life span of the RRS.

Table 6-1. Contact History Summary

	NASA Space Network - 1992	AF Satellite Control Network	TDRSS
DRM-1 (350 km -33°)	<ul style="list-style-type: none"> • Can get 2 Contacts Per Day • Maximum 8 Minutes Coverage • Cannot Get Coverage 10-12 Hours Separation 	<ul style="list-style-type: none"> • Can Get 2 Contacts Per Day • Maximum Coverage 8 Minutes • Can Schedule to Get Coverage - 10-12 Hours Separation • Foreign Sites Only 	<ul style="list-style-type: none"> • Allows Coverage at any Time Needed • Data Received in USA • Only Limitation is Scheduling • Greater Than 80% Coverage Available Each Day
DRM-2 (900 km 33°)	<ul style="list-style-type: none"> • Same as 350 km 	<ul style="list-style-type: none"> • Can Get 2 Contacts Per Day • Maximum Coverage 12-14 Minutes • Can Schedule Coverage - 10-12 Hours Separation • Foreign Sites 	<ul style="list-style-type: none"> • Same as 350 km • Greater Than 95% Coverage Available Each Day
DRM-3 (897 km 98°)	<ul style="list-style-type: none"> • Can Get 2 Contacts Per Day • Can Get 10 Minute Coverage • Can Get Coverage - 10-12 Hours Separation in USA 	<ul style="list-style-type: none"> • Same as 33° Inclination • Possible U.S. Site Coverage 	<ul style="list-style-type: none"> • Same as 900 km, 33° Inclination

7.0 CONCLUSIONS/RECOMMENDATIONS

Based on the site coverage printouts and the resulting ground plots, it is recommended that the TDRSS and associated ground network be utilized to support the RRS over its 10-year life (1992 - 2002). Either the NASA Space Network or the AF Satellite Control Network could be used as a backup to the TDRSS should there ever be a scheduling conflict due to a manned space flight emergency or other unforeseen complications.

APPENDIX A

RRS CONTACT HISTORIES - NASA GROUND STATIONS

Sen:	Time	AZ	Sat:	EL	Range
					1833.32
					349.808
					1832.33

Sen:	Time	AZ	Sat:	EL	Range
					1832.77
					1531.79
					1833.69

**CONTACT HISTORY
NASA GROUND STATIONS**

**DRM 1
Alt 350 km
Incl. 33.83°**

Sen:	Time	AZ	Sat:	EL	Range
					1832.37
					616.553
					1833.48

Sen:	Time	AZ	Sat:	EL	Range
					1832.93
					645.584
					1832.36

Sen:	Time	AZ	Sat:	EL	Range
					1834.18
					1314.73
					1832.96

Sen:	Time	AZ	Sat:	EL	Range
					1832.45
					393.520
					1832.75

Sen:	Time	AZ	Sat:	EL	Range
					1832.99
					1362.55
					1834.10

Sen:	Time	AZ	Sat:	EL	Range
					1833.32
					583.146
					1832.32

Sen:	Time	AZ	Sat:	EL	Range
					1833.32
					583.146
					1832.32

Time		AZ	EL	Range
186.387	03:06	293.931	3.00003	1832.32
190.433	03:10	6.92701	29.5646	658.912
194.481	03:14	79.8916	2.99994	1833.09

Sen:	Time	AZ	EL	1	Range
	446				
	189.664	03:10	279.904	3.00002	1832.41
	193.873	03:14	196.340	60.6939	397.820
	198.084	03:19	112.783	3.00007	1833.86

Sen:	Time	AZ	EL	1	Range
	456				
	274.603	04:35	263.497	3.00003	1832.49
	278.821	04:39	178.842	65.4592	382.161
	283.038	04:43	94.3073	2.99995	1832.65

Sen:	Time	AZ	EL	1	Range
	445				
	282.978	04:43	289.809	3.00009	1832.63
	287.215	04:47	197.752	89.5238	349.882
	291.454	04:51	111.040	3.00003	1834.43

Sen:	Time	AZ	EL	1	Range
	446				
	286.732	04:47	262.869	3.00008	1833.31
	290.167	04:50	208.368	13.6773	1111.59
	293.607	04:54	153.790	3.00002	1834.92

Sen:	Time	AZ	EL	1	Range
	456				
	371.172	06:11	270.531	3.00006	1832.33
	375.303	06:15	193.132	40.4929	520.548
	379.437	06:19	115.743	3.00011	1833.67

Sen:	Time	AZ	EL	1	Range
	445				
	380.096	06:20	266.594	3.00010	1833.83
	383.567	06:23	211.271	14.1021	1092.85
	387.043	06:27	155.863	3.00000	1835.46

Sen:	Time	AZ	EL	1	Range
	456				
	468.202	07:48	257.841	2.99988	1833.16
	471.522	07:51	205.888	12.4070	1172.38
	474.848	07:55	153.870	2.99993	1834.78

Sen:	Time	AZ	EL	1	Range
	449				
	1091.56	18:12	195.158	3.00015	1832.44

1098.75 18:17 118.790 2.99990 1832.00

Sen: 453 Sat: 1
Time AZ EL Range
1134.17 18:54 358.681 3.00084 1835.79
1136.37 18:56 30.2365 5.93420 1582.94
1138.56 18:59 61.7324 3.00082 1834.50

Sen: 449 Sat: 1
Time AZ EL Range
1186.43 19:46 232.384 3.00028 1831.98
1190.15 19:50 170.381 18.5818 918.793
1193.88 19:54 108.480 3.00002 1832.26

Sen: 453 Sat: 1
Time AZ EL Range
1228.48 20:28 309.335 2.99998 1835.14
1232.43 20:32 18.3628 25.6380 733.672
1236.39 20:36 87.4164 3.00021 1832.94

Sen: 445 Sat: 1
Time AZ EL Range
1267.82 21:08 169.737 3.00397 1832.71
1269.59 21:10 144.795 4.77315 1674.88
1271.35 21:11 119.925 3.00402 1832.25

Sen: 446 Sat: 1
Time AZ EL Range
1270.08 21:10 200.972 2.99986 1832.81
1273.32 21:13 150.595 11.6236 1211.38
1276.56 21:17 100.329 2.99990 1832.02

Sen: 449 Sat: 1
Time AZ EL Range
1282.49 21:22 249.717 2.99972 1831.95
1286.32 21:26 184.775 21.1643 841.088
1290.15 21:30 119.905 3.00016 1833.32

Sen: 453 Sat: 1
Time AZ EL Range
1324.62 22:04 281.633 3.00051 1833.76
1328.83 22:09 4.38967 58.3071 406.958
1333.03 22:13 87.4981 2.99986 1832.26

Sen: 445 Sat: 1
Time AZ EL Range
1361.65 22:42 229.924 3.00001 1832.65
1365.76 22:46 153.996 36.6118 560.678
1369.86 22:50 78.2768 3.00010 1831.80

Sen:	446		Sat:	1	
	Time	AZ	EL		Range
	1365.39	22:45 243.968	2.99990		1832.18
	1369.58	22:50 162.227	52.9289		431.542
	1373.76	22:54 80.8106	3.00003		1831.87

Sen:	449		Sat:	1	
	Time	AZ	EL		Range
	1379.20	22:59 248.035	2.99984		1832.75
	1382.40	23:02 198.715	11.2399		1233.05
	1385.60	23:06 149.382	2.99985		1834.67

Sen:	453		Sat:	1	
	Time	AZ	EL		Range
	1421.15	23:41 270.388	3.00000		1832.67
	1425.32	23:45 350.050	47.2040		466.105
	1429.48	23:49 70.0107	3.00002		1832.18

Sen:	456		Sat:	1	
	Time	AZ	EL		Range
	1454.23	24:14 165.410	3.01873		1830.60
	1455.49	24:15 147.948	3.86862		1752.65
	1456.73	24:17 130.555	3.01901		1830.28

- 24 Hours

Sen:	445		Sat:	1	
	Time	AZ	EL		Range
	1458.19	267.210	3.00014		1831.90
	1462.34	346.565	42.3590		503.188
	1466.50	65.7578	3.00005		1831.96

Sen:	446		Sat:	1	
	Time	AZ	EL		Range
	1461.96	270.908	3.00030		1831.68
	1466.19	356.531	63.3994		388.238
	1470.41	81.6424	3.00008		1832.68

Sen:	453		Sat:	1	
	Time	AZ	EL		Range
	1517.98	277.745	2.99982		1832.14
	1521.60	336.908	16.5309		991.181
	1525.23	36.2124	3.00014		1832.42

Sen:	445		Sat:	1	
	Time	AZ	EL		Range
	1555.28	290.043	2.99992		1831.69
	1559.28	0.907662	26.4492		715.884
	1563.27	71.6329	3.00022		1833.07

Sen:	456		Sat:	1	
	Time	AZ	EL		Range
	1547.65	224.930	3.00007		1832.00
	1551.50	159.274	21.7428		824.811
	1555.34	93.7794	3.00020		1831.66

Sen:	446		Sat:	1	
	Time	AZ	EL		Range
	1558.65	281.030	3.00005		1832.03
	1562.89	12.2131	84.7822		351.108
	1567.13	100.301	3.00007		1834.33

Sen:	456		Sat:	1	
	Time	AZ	EL		Range
	1643.66	255.475	3.00027		1831.54
	1647.86	172.673	56.8507		412.701
	1652.06	90.3269	3.00041		1832.36

Sen:	445		Sat:	1	
	Time	AZ	EL		Range
	1652.00	293.706	2.99983		1832.41
	1656.19	15.2280	48.4049		458.678
	1660.38	96.4018	3.00023		1835.03

Sen:	446		Sat:	1	
	Time	AZ	EL		Range
	1655.39	272.842	3.00012		1833.31
	1659.34	203.624	25.7776		731.193
	1663.30	134.452	3.00001		1836.09

Sen:	456		Sat:	1	
	Time	AZ	EL		Range
	1740.17	269.754	2.99968		1831.80
	1744.37	187.088	56.3945		415.057
	1748.57	104.843	3.00007		1833.93

Sen:	445		Sat:	1	
	Time	AZ	EL		Range
	1748.70	279.142	3.00065		1833.92
	1752.72	207.084	29.7025		658.308
	1756.76	135.071	3.00013		1836.85

Sen:	446		Sat:	1	
	Time	AZ	EL		Range
	1754.28	229.762	3.02495		1833.68
	1755.41	214.017	3.71799		1770.33
	1756.55	198.219	3.02433		1834.51

Sen:	456		Sat:	1	
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Time	Hz	EL	Range
1836.88	266.040	2.99982	1832.95
1840.72	200.791	21.4210	835.267
1844.57	135.580	2.99959	1835.74

Sen:	Time	AZ	Sat:	EL	Range
	445			1	
	1848.49	221.006		3.05345	1832.04
	1848.85	216.003		3.12266	1825.68
	1849.22	210.960		3.05363	1832.24

Sen:	Time	AZ	Sat:	EL	Range
	456			1	
	1935.59	227.983		3.02439	1833.34
	1936.73	212.155		3.72593	1769.26
	1937.88	196.280		3.02422	1834.21

Sen:	Time	AZ	Sat:	EL	Range
	449			1	
	2463.17	156.305		3.05174	1825.84
	2463.50	151.849		3.10554	1820.80
	2463.82	147.434		3.05112	1825.88

Sen:	Time	AZ	Sat:	EL	Range
	449			1	
	2555.91	219.841		2.99996	1830.56
	2559.37	164.559		14.0857	1090.33
	2562.83	109.415		3.00000	1831.28

Sen:	Time	AZ	Sat:	EL	Range
	453			1	
	2598.04	325.857		3.00037	1837.49
	2601.62	23.5896		15.5729	1031.63
	2605.19	81.3417		2.99949	1834.75

Sen:	Time	AZ	Sat:	EL	Range
	446			1	
	2640.88	170.483		3.00507	1830.30
	2642.58	146.557		4.62842	1684.93
	2644.27	122.714		3.00522	1830.03

Sen:	Time	AZ	Sat:	EL	Range
	449			1	
	2651.64	244.594		2.99951	1830.79
	2655.50	178.689		22.0475	816.635
	2659.35	112.972		2.99951	1832.86

Sen:	Time	AZ	Sat:	EL	Range
	453			1	
	2693.72	291.258		2.99990	1835.96

2702.05

89.7131

2.99981

1832.95

Sen:	445		Sat:	1	
	Time	AZ		EL	Range
	2731.23	210.136		3.00028	1830.70
	2734.89	149.738		17.2100	964.847
	2738.55	89.5058		3.00096	1830.24

Sen:	446		Sat:	1	
	Time	AZ		EL	Range
	2734.67	228.358		3.00010	1830.44
	2738.67	157.035		28.4697	676.594
	2742.67	85.9735		3.00022	1830.59

Sen:	449		Sat:	1	
	Time	AZ		EL	Range
	2748.05	251.419		3.00107	1831.72
	2751.64	193.004		16.0019	1012.26
	2755.24	134.679		3.00048	1834.73

Sen:	453		Sat:	1	
	Time	AZ		EL	Range
	2790.17	272.963		3.00009	1834.05
	2794.37	355.701		59.3070	402.950
	2798.58	79.3186		3.00012	1831.86

Sen:	445		Sat:	1	
	Time	AZ		EL	Range
	2827.07	253.147		2.99988	1830.27
	2831.30	341.715		75.6135	359.532
	2835.52	68.8343		2.99965	1830.79

Sen:	446		Sat:	1	
	Time	AZ		EL	Range
	2830.92	261.536		2.99975	1830.26
	2835.15	351.651		80.1591	353.927
	2839.38	79.0883		3.00001	1831.76

Sen:	449		Sat:	1	
	Time	AZ		EL	Range
	2845.77	231.376		3.00374	1834.03
	2847.57	206.095		4.84562	1671.13
	2849.36	180.789		3.00408	1835.73

Sen:	453		Sat:	1	
	Time	AZ		EL	Range
	2886.80	272.132		2.99994	1832.51
	2890.78	342.098		27.0325	704.143
	2894.75	52.3714		3.00093	1831.29

an:	456		Sat:	1	
	Time	AZ		EL	Range
	2917.36	206.732		3.00095	1830.10
	2920.70	154.215		12.6120	1158.91
	2924.03	101.852		3.00097	1830.16

an:	445		Sat:	1	
	Time	AZ		EL	Range
	2924.09	282.700		3.00066	1830.19
	2928.12	354.867		28.1492	682.716
	2932.14	66.7790		3.00019	1832.17

an:	446		Sat:	1	
	Time	AZ		EL	Range
	2927.63	279.008		2.99969	1830.86
	2931.86	5.29248		65.0143	383.370
	2936.08	90.4626		2.99913	1833.96

an:	453		Sat:	1	
	Time	AZ		EL	Range
	2984.48	295.758		3.00055	1831.41
	2986.86	330.226		6.57066	1530.44
	2989.24	4.80653		3.00059	1831.12

an:	456		Sat:	1	
	Time	AZ		EL	Range
	3012.79	244.655		3.00098	1829.88
	3016.92	166.829		40.9898	514.766
	3021.05	89.4488		2.99925	1831.36

an:	445		Sat:	1	
	Time	AZ		EL	Range
	3021.00	294.528		3.00017	1831.26
	3025.09	9.47909		32.5426	613.071
	3029.17	84.0665		2.99976	1834.73

an:	446		Sat:	1	
	Time	AZ		EL	Range
	3024.27	278.570		3.00032	1832.42
	3028.45	198.255		47.8716	462.503
	3032.63	118.433		2.99985	1836.45

an:	445		Sat:	1	
	Time	AZ		EL	Range
	3117.58	287.421		2.99967	1833.29
	3121.80	201.890		66.7967	379.529
	3126.03	117.440		2.99952	1837.51

Time	AZ	EL	Range
4062.94	303.599	2.99965	1838.70
4066.99	16.0412	30.7664	641.759
4071.03	88.7632	2.99938	1834.77

Sen:	Time	AZ	EL	Range
	4101.49	184.524	3.00064	1828.58
	4104.10	146.070	7.50158	1460.18
	4106.70	107.726	3.00033	1828.32

Sen:	Time	AZ	EL	Range
	4104.30	209.622	3.00025	1828.40
	4107.84	152.304	15.1862	1041.24
	4111.37	95.1737	2.99932	1828.73

Sen:	Time	AZ	EL	Range
	4117.06	250.849	3.00109	1830.04
	4120.84	187.060	20.0311	873.315
	4124.63	123.493	2.99896	1834.06

Sen:	Time	AZ	EL	Range
	4159.20	278.571	3.00102	1836.28
	4163.41	1.54829	61.0767	396.940
	4167.63	85.7625	3.00050	1832.61

Sen:	Time	AZ	EL	Range
	4196.15	236.953	3.00104	1828.16
	4200.32	155.663	50.6372	442.802
	4204.49	74.9591	3.00195	1828.68

Sen:	Time	AZ	EL	Range
	4199.95	249.462	3.00103	1828.16
	4204.16	163.843	66.5387	377.941
	4208.37	79.6945	3.00066	1829.96

Sen:	Time	AZ	EL	Range
	4213.94	245.231	3.00080	1832.63
	4216.88	200.827	9.35892	1343.08
	4219.83	156.469	2.99970	1836.34

Sen:	Time	AZ	EL	Range
	4255.76	270.222	2.99938	1834.06

4264.03

65.5267

3.0001

1828.17

Sen:	456	Sat:	1	Range
Time	AZ	EL		
4287.75	181.620	3.00025		1828.08
4289.97	149.616	6.00957		1570.14
4292.18	117.727	3.00026		1828.15

Sen:	445	Sat:	1	Range
Time	AZ	EL		
4292.87	272.191	2.99917		1828.33
4296.98	348.993	36.0349		565.840
4301.09	65.3790	3.00167		1830.32

Sen:	446	Sat:	1	Range
Time	AZ	EL		
4296.59	273.838	2.99999		1828.91
4300.81	359.328	61.1360		395.282
4305.02	83.5366	3.00051		1832.43

DRM 2
Alt 900 km
Incl. 33.83°

Sen:	446	Sat:	2	Range
Time	AZ	EL		
-7.26577	256.655	2.99997		3187.91
0.620110	167.898	89.1922		899.717
8.50630	79.2588	2.99999		3186.99

Sen:	449	Sat:	2	Range
Time	AZ	EL		
8.03251	264.710	2.99999		3186.98
14.8178	204.472	23.0687		1805.94
21.6141	144.071	3.00002		3188.29

Sen:	453	Sat:	2	Range
Time	AZ	EL		
55.9451	264.460	3.00000		3186.97
63.6745	343.335	54.9430		1067.49
71.4071	62.3618	2.99998		3188.06

Sen:	456	Sat:	2	Range
Time	AZ	EL		
90.3395	221.240	3.00000		3188.42
97.5991	153.494	31.6176		1500.81
104.848	85.9560	2.99999		3187.01

Sen:	445	Sat:	2	Range
Time	AZ	EL		
98.1657	273.435	2.99994		3187.56
105.941	354.068	53.6728		1081.51
113.718	74.7481	2.99992		3187.16

Sen:	446		Sat:	2	
Time		AZ	EL		Range
102.310		276.024	3.00000		3187.16
110.195		4.24598	78.4965		915.672
118.079		92.3945	3.00005		3187.58
Sen:	449		Sat:	2	
Time		AZ	EL		Range
119.618		243.522	3.00001		3187.77
123.033		217.071	5.87740		2913.33
126.459		190.534	2.99999		3188.57
Sen:	453		Sat:	2	
Time		AZ	EL		Range
165.714		269.850	3.00005		3187.14
172.470		329.698	22.5993		1826.57
179.240		29.7580	2.99999		3188.47
Sen:	445		Sat:	2	
Time		AZ	EL		Range
208.043		287.922	3.00001		3186.97
215.863		10.6035	59.4217		1023.31
223.680		93.1650	3.00006		3187.96
Sen:	456		Sat:	2	
Time		AZ	EL		Range
198.747		250.774	3.00001		3187.75
206.568		167.989	66.8218		967.745
214.387		85.3315	3.00001		3187.03
Sen:	446		Sat:	2	
Time		AZ	EL		Range
211.810		282.085	2.99995		3186.94
219.621		199.821	65.2287		978.280
227.434		117.397	3.00003		3188.43
Sen:	453		Sat:	2	
Time		AZ	EL		Range
280.112		314.267	3.02860		3185.35
280.819		319.600	3.13942		3174.30
281.532		324.973	3.02822		3185.52
Sen:	456		Sat:	2	
Time		AZ	EL		Range
308.022		269.937	3.00010		3187.09
315.887		184.233	77.6641		918.130
323.752		98.5734	2.99993		3187.67

Sen:	Time	AZ	EL	Range
	317.561	287.846	3.00004	3187.06
	325.380	205.110	66.5208	970.057
	333.202	122.167	3.00011	3188.81

Sen:	Time	AZ	EL	Range
	321.691	273.171	3.00007	3187.42
	328.510	212.441	23.3840	1793.13
	335.345	151.485	2.99999	3189.00

Sen:	Time	AZ	EL	Range
	417.423	276.201	3.00006	3186.93
	425.071	199.880	48.1707	1152.95
	432.724	123.412	3.00001	3188.51

Sen:	Time	AZ	EL	Range
	427.778	272.191	3.00006	3187.85
	434.278	215.722	19.4884	1973.91
	440.796	159.016	2.99998	3189.21

Sen:	Time	AZ	EL	Range
	527.455	266.962	3.00001	3187.49
	533.769	212.798	17.8406	2059.96
	540.099	158.438	3.00003	3189.07

Sen:	Time	AZ	EL	Range
	1016.30	191.126	3.00006	3187.72
	1021.66	147.291	11.7193	2441.46
	1027.00	103.609	3.00000	3186.90

Sen:	Time	AZ	EL	Range
	1064.89	1.91103	3.00007	3189.54
	1069.38	37.5718	8.41460	2695.75
	1073.86	73.1071	2.99997	3188.41

Sen:	Time	AZ	EL	Range
	1122.83	227.869	2.99996	3187.36
	1130.04	160.967	30.6374	1529.66
	1137.24	94.2365	3.00012	3186.88

Sen:	Time	AZ	EL	Range

1170.59	318.574	2.99997	3189.35
1177.85	26.2401	31.5382	1503.64
1185.10	93.7290	3.00003	3187.30

Sen:	445		Sat:	2	
	Time	AZ		EL	Range
	1215.54	176.673		3.00012	3187.88
	1220.04	140.849		8.41949	2694.03
	1224.54	105.165		3.00012	3187.37

Sen:	446		Sat:	2	
	Time	AZ		EL	Range
	1218.05	198.073		2.99997	3187.82
	1224.27	145.007		16.8602	2113.64
	1230.47	92.1631		2.99998	3186.93

Sen:	449		Sat:	2	
	Time	AZ		EL	Range
	1231.22	252.070		3.00013	3186.87
	1238.83	176.791		45.7427	1189.58
	1246.44	101.607		2.99985	3187.56

Sen:	453		Sat:	2	
	Time	AZ		EL	Range
	1278.99	289.222		2.99980	3188.65
	1286.81	11.6085		65.7757	974.636
	1294.62	94.0399		3.00033	3186.86

Sen:	445		Sat:	2	
	Time	AZ		EL	Range
	1321.27	221.510		2.99995	3187.72
	1328.75	149.270		38.5635	1324.44
	1336.22	77.3269		2.99990	3186.76

Sen:	446		Sat:	2	
	Time	AZ		EL	Range
	1325.31	234.943		2.99994	3187.48
	1333.02	156.648		52.4750	1095.56
	1340.72	78.6294		2.99975	3186.78

Sen:	449		Sat:	2	
	Time	AZ		EL	Range
	1340.25	264.547		2.99993	3186.75
	1347.70	193.040		38.1507	1333.59
	1355.16	121.484		3.00003	3188.53

Sen:	453		Sat:	2	
	Time	AZ		EL	Range
	1388.25	270.303		3.00015	3187.67

1403.97	60.5358	3.00001	3186.99
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Sen:	456		Sat:	2	
	Time	AZ	EL	Range	
	1424.99	190.629	3.00000	3187.59	
	1430.56	144.605	12.7336	2370.73	
	1436.12	98.7661	2.99997	3186.83	

Sen:	445		Sat:	2	
	Time	AZ	EL	Range	
	1430.08	254.031	3.00012	3187.24	
	1437.96	342.247	78.7985	914.719	
	1445.84	70.3183	3.00002	3186.86	

Sen:	446		Sat:	2	
	Time	AZ	EL	Range	
	1434.44	262.331	3.00023	3186.90	
	1442.33	352.021	83.2723	904.901	
	1450.22	81.1488	2.99975	3187.34	

Sen:	449		Sat:	2	
	Time	AZ	EL	Range	
	1449.88	262.696	3.00003	3187.27	
	1456.26	207.728	18.5106	2024.01	
	1462.66	152.618	3.00034	3189.30	

Sen:	453		Sat:	2	
	Time	AZ	EL	Range	
	1497.65	264.300	2.99995	3187.02	
	1505.27	339.773	46.2850	1181.02	
	1512.89	55.4976	3.00038	3187.27	

Sen:	456		Sat:	2	
	Time	AZ	EL	Range	
	1531.64	229.134	3.00021	3187.25	
	1539.14	156.661	39.4219	1305.81	
	1546.62	84.4308	3.00018	3186.70	

Sen:	445		Sat:	2	
	Time	AZ	EL	Range	
	1540.00	278.164	3.00022	3186.70	
	1547.76	358.071	51.5368	1107.05	
	1555.51	77.8956	3.00011	3187.67	

Sen:	446		Sat:	2	
	Time	AZ	EL	Range	
	1544.04	278.742	2.99978	3186.67	
	1551.92	8.43321	82.9881	905.605	
	1559.81	97.4157	3.00047	3189.38	

Sen:	453		Sat:	2	
Time		AZ	EL		Range
1607.73		273.973	3.00022		3186.84
1613.94		326.932	16.9916		2105.96
1620.17		20.1063	3.00027		3187.46
Sen:	456		Sat:	2	
Time		AZ	EL		Range
1640.37		256.375	3.00012		3186.78
1648.22		171.657	73.3536		933.629
1656.07		87.2928	2.99970		3187.38
Sen:	445		Sat:	2	
Time		AZ	EL		Range
1649.77		289.217	2.99991		3186.72
1657.63		14.4366	67.4134		964.410
1665.49		99.3240	3.00003		3188.98
Sen:	446		Sat:	2	
Time		AZ	EL		Range
1653.53		281.424	3.00000		3187.03
1661.24		203.113	53.0499		1089.46
1668.96		124.694	3.00012		3189.54
Sen:	445		Sat:	2	
Time		AZ	EL		Range
1759.31		285.696	3.00036		3187.38
1767.00		207.997	51.1796		1112.74
1774.70		130.133	3.00007		3189.98
Sen:	456		Sat:	2	
Time		AZ	EL		Range
1749.70		272.673	3.00013		3186.57
1757.55		187.991	73.4342		933.549
1765.41		103.549	3.00024		3188.46
Sen:	446		Sat:	2	
Time		AZ	EL		Range
1763.76		268.132	3.00035		3188.14
1770.00		214.864	17.1511		2098.92
1776.26		161.399	3.00011		3190.12
Sen:	456		Sat:	2	
Time		AZ	EL		Range
1859.15		275.586	3.00013		3186.99
1866.64		203.226	39.5586		1303.91
1874.14		130.748	3.00005		3189.59

Sen:	445		Sat:	2	
	Time	AZ	EL		Range
	1870.08	264.951	3.00015		3188.86
	1875.79	217.569	13.4681		2323.88
	1881.51	169.997	2.99989		3190.37

Sen:	456		Sat:	2	
	Time	AZ	EL		Range
	1969.64	261.351	3.00017		3188.25
	1975.22	215.339	12.8205		2366.80
	1980.81	169.166	2.99956		3190.22

Sen:	449		Sat:	2	
	Time	AZ	EL		Range
	2457.00	201.532	3.00033		3186.57
	2463.06	150.282	15.7919		2174.80
	2469.11	99.2186	2.99993		3186.29

Sen:	453		Sat:	2	
	Time	AZ	EL		Range
	2505.22	349.007	3.00015		3190.66
	2510.81	35.2074	12.8389		2366.07
	2516.40	81.2466	3.00004		3188.82

Sen:	449		Sat:	2	
	Time	AZ	EL		Range
	2564.18	234.611	3.00025		3186.28
	2571.55	164.568	35.3737		1398.10
	2578.92	94.7290	3.00038		3186.87

Sen:	453		Sat:	2	
	Time	AZ	EL		Range
	2611.89	310.706	3.00010		3190.27
	2619.39	22.9934	39.2288		1311.26
	2626.87	95.1788	3.00042		3187.43

Sen:	445		Sat:	2	
	Time	AZ	EL		Range
	2655.83	189.996	2.99971		3186.77
	2661.55	142.420	13.4562		2321.59
	2667.25	95.0568	2.99962		3186.26

Sen:	446		Sat:	2	
	Time	AZ	EL		Range
	2658.95	208.046	3.00007		3186.63
	2665.76	147.414	23.0375		1806.29
	2672.55	87.0468	2.99964		3186.17

Sen:	449		Sat:	2	
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2571.70	206.170	3.00001	3186.00
2620.40	180.665	46.2330	1181.72
2688.02	105.288	3.00002	3188.10

Sen:	453	Sat:	2
Time	AZ	EL	Range
2720.61	283.672	3.00026	3189.23
2728.46	7.68093	72.0093	940.103
2736.31	92.0089	3.00046	3186.72

Sen:	445	Sat:	2
Time	AZ	EL	Range
2762.64	229.888	3.00019	3186.49
2770.34	151.914	51.1985	1110.96
2778.02	74.2979	3.00062	3186.11

Sen:	446	Sat:	2
Time	AZ	EL	Range
2766.83	242.263	3.00028	3186.27
2774.64	159.890	64.6268	981.665
2782.44	77.9285	2.99948	3186.62

Sen:	449	Sat:	2
Time	AZ	EL	Range
2781.91	265.554	2.99954	3186.55
2789.23	196.715	33.6347	1444.20
2796.56	127.845	2.99976	3189.45

Sen:	453	Sat:	2
Time	AZ	EL	Range
2829.94	267.626	3.00036	3187.97
2837.78	351.317	71.1744	943.636
2845.62	75.5074	3.00057	3186.48

Sen:	456	Sat:	2
Time	AZ	EL	Range
2865.70	201.391	2.99960	3186.46
2872.01	147.142	17.7408	2063.45
2878.31	93.1216	2.99986	3186.04

Sen:	445	Sat:	2
Time	AZ	EL	Range
2871.85	260.707	2.99974	3186.15
2879.70	345.840	67.3616	963.941
2887.55	70.7863	3.00034	3186.85

Sen:	446	Sat:	2
Time	AZ	EL	Range
2876.18	267.384	3.00026	3185.98

Sen:	446		Sat:	2	
Time		AZ	EL		Range
3095.28		279.910	2.99958		3187.27
3102.82		206.234	41.9906		1256.21
3110.38		132.457	3.00035		3190.61
Sen:	456		Sat:	2	
Time		AZ	EL		Range
3191.39		274.645	3.00046		3186.11
3199.21		191.755	66.9306		967.281
3207.03		109.141	2.99958		3189.40
Sen:	445		Sat:	2	
Time		AZ	EL		Range
3201.11		282.666	2.99978		3187.91
3208.58		210.666	38.5560		1326.28
3216.07		138.507	2.99972		3191.16
Sen:	446		Sat:	2	
Time		AZ	EL		Range
3206.08		261.223	2.99981		3189.14
3211.47		217.050	11.8765		2433.21
3216.89		172.722	2.99993		3191.23
Sen:	456		Sat:	2	
Time		AZ	EL		Range
3300.92		274.073	2.99990		3187.21
3308.18		206.405	31.7390		1498.23
3315.45		138.631	3.00016		3190.63
Sen:	445		Sat:	2	
Time		AZ	EL		Range
3312.79		254.852	2.99989		3190.10
3317.29		219.141	8.42993		2696.34
3321.80		183.303	3.00004		3191.45
Sen:	456		Sat:	2	
Time		AZ	EL		Range
3412.18		253.137	3.00015		3189.26
3416.65		217.663	8.39214		2698.85
3421.14		182.074	2.99989		3191.19
Sen:	449		Sat:	2	
Time		AZ	EL		Range
3794.56		154.807	3.00376		3185.16
3796.34		141.319	3.71719		3114.23
3798.11		127.882	3.00376		3185.05

Sen:	449		Sat:	2	
	Time	AZ		EL	Range
	3897.94	210.675		2.99968	3185.47
	3904.49	153.437		20.1686	1937.22
	3911.03	96.4187		2.99963	3185.65
Sen:	453		Sat:	2	
	Time	AZ		EL	Range
	3945.93	338.284		3.00037	3191.73
	3952.26	32.6177		17.8459	2061.76
	3958.58	86.7878		3.00082	3189.12
Sen:	446		Sat:	2	
	Time	AZ		EL	Range
	3995.12	168.682		2.99991	3185.62
	3998.73	140.542		6.22497	2879.40
	4002.34	112.506		3.00052	3185.26
Sen:	449		Sat:	2	
	Time	AZ		EL	Range
	4005.60	240.745		2.99959	3185.30
	4013.09	168.266		39.6795	1299.73
	4020.57	96.0405		3.00000	3187.02
Sen:	453		Sat:	2	
	Time	AZ		EL	Range
	4053.30	303.395		3.00109	3191.06
	4060.96	19.5677		47.6507	1161.69
	4068.60	95.7315		3.00064	3187.55
Sen:	445		Sat:	2	
	Time	AZ		EL	Range
	4096.55	200.986		3.00022	3185.58
	4103.06	144.269		19.4756	1971.63
	4109.55	87.8132		2.99960	3185.24
Sen:	446		Sat:	2	
	Time	AZ		EL	Range
	4100.06	217.113		3.00036	3185.40
	4107.27	150.049		30.4650	1533.74
	4114.47	83.2869		3.00029	3185.43
Sen:	449		Sat:	2	
	Time	AZ		EL	Range
	4114.37	259.593		2.99926	3185.53
	4121.97	184.533		45.1527	1199.07
	4129.57	109.647		3.00024	3188.68
Sen:	453		Sat:	2	

4182.26	278.743	3.00076	3189.77
4170.13	3.57616	75.9957	924.068
4177.99	89.2164	3.00036	3186.57

Sen:	456	Sat:	2
Time	AZ	EL	Range
4203.51	151.956	3.00583	3184.74
4205.12	139.798	3.58092	3127.40
4206.71	127.690	3.00656	3184.53

Sen:	445	Sat:	2
Time	AZ	EL	Range
4204.14	237.858	2.99985	3185.31
4211.95	154.740	66.5578	968.404
4219.77	72.1502	3.00060	3185.63

Sen:	446	Sat:	2
Time	AZ	EL	Range
4208.43	249.114	3.00074	3185.07
4216.29	163.157	76.7433	920.234
4224.14	78.0498	3.00149	3186.33

Sen:	449	Sat:	2
Time	AZ	EL	Range
4223.61	265.720	3.00099	3186.27
4230.73	200.284	28.8249	1588.52
4237.87	134.820	3.00023	3190.29

Sen:	453	Sat:	2
Time	AZ	EL	Range
4271.62	265.713	3.00051	3188.23
4279.42	347.509	64.6426	981.936
4287.23	69.8645	2.99969	3186.08

Sen:	456	Sat:	2
Time	AZ	EL	Range
4306.65	210.904	3.00057	3185.17
4313.48	149.884	23.4912	1785.96
4320.30	89.1353	3.00061	3185.30

Sen:	449	Sat:	3
Time	AZ	EL	Range
69.5162	80.7263	3.00001	3182.29
72.8136	53.1705	6.18332	2878.79
76.0949	25.7578	3.00000	3179.93

Sen:	456	Sat:	3
Time	AZ	EL	Range
92.9316	335.140	3.00000	3180.30

DRM 3
Alt 897 km
Incl. 98.0°

101.061 265.875 3.00000 3183.20

Sen: 449 Sat: 3
Time AZ EL Range
166.063 148.310 3.00001 3184.32
173.184 71.3836 49.4543 1131.63
180.295 354.844 2.99998 3179.59

Sen: 453 Sat: 3
Time AZ EL Range
219.290 69.5508 3.00002 3183.67
224.617 117.215 13.7767 2296.33
229.920 164.607 3.00000 3180.04

Sen: 449 Sat: 3
Time AZ EL Range
268.751 206.250 3.00000 3184.43
275.125 267.613 22.4085 1830.59
281.519 329.271 3.00007 3180.13

Sen: 453 Sat: 3
Time AZ EL Range
318.300 8.67029 3.00011 3184.41
325.611 281.745 74.9006 925.401
332.927 194.413 2.99987 3180.01

Sen: 446 Sat: 3
Time AZ EL Range
371.812 120.986 2.99996 3184.46
377.700 66.5234 18.0560 2043.34
383.563 12.3842 2.99999 3180.47

Sen: 453 Sat: 3
Time AZ EL Range
424.439 297.923 2.99993 3183.78
428.087 267.174 6.70334 2834.40
431.740 236.378 2.99998 3181.39

Sen: 445 Sat: 3
Time AZ EL Range
471.931 142.684 2.99998 3184.95
478.799 72.3204 35.4818 1393.44
485.648 2.38139 3.00017 3180.79

Sen: 446 Sat: 3
Time AZ EL Range
471.730 180.919 2.99986 3184.98
478.922 260.452 51.7875 1101.93
486.126 340.437 3.00004 3180.63

Sen:	445		Sat:	3	
Time		AZ	EL		Range
574.061		202.499	2.99999		3185.06
580.457		264.215	23.0569		1803.46
586.875		326.288	3.00010		3181.48
Sen:	456		Sat:	3	
Time		AZ	EL		Range
578.442		121.735	2.99991		3184.40
584.457		65.5917	19.3899		1973.49
590.448		9.76823	3.00008		3180.18
Sen:	456		Sat:	3	
Time		AZ	EL		Range
678.498		180.735	2.99999		3184.98
685.699		260.568	52.3497		1094.91
692.910		340.841	3.00000		3180.38
Sen:	449		Sat:	3	
Time		AZ	EL		Range
915.294		26.4811	3.00034		3179.66
922.055		94.5800	29.4078		1564.71
928.798		162.354	2.99994		3183.86
Sen:	453		Sat:	3	
Time		AZ	EL		Range
970.906		127.564	2.99994		3181.74
975.060		92.0674	8.03886		2721.15
979.205		56.6624	2.99993		3184.63
Sen:	449		Sat:	3	
Time		AZ	EL		Range
1016.89		2.03837	2.99988		3179.33
1023.79		290.906	37.9922		1333.18
1030.71		219.381	2.99992		3183.60
Sen:	453		Sat:	3	
Time		AZ	EL		Range
1070.14		166.961	3.00017		3180.34
1077.46		77.4756	82.7905		904.005
1084.78		348.541	3.00002		3185.17
Sen:	449		Sat:	3	
Time		AZ	EL		Range
1122.32		322.738	3.00687		3179.27
1123.93		309.616	3.70774		3110.16
1125.55		296.395	3.00668		3180.35

Sen:	Time	AZ	Sat:	EL	Range
	1124.95	42.0460		3.00014	3180.80
	1130.48	92.1261		14.2253	2268.14
	1136.00	141.978		3.00004	3183.95

Sen:	Time	AZ	Sat:	EL	Range
	1173.33	197.352		2.99988	3180.48
	1178.38	241.951		12.3122	2395.24
	1183.45	286.797		3.00005	3184.26

Sen:	Time	AZ	Sat:	EL	Range
	1227.39	25.7835		3.00013	3180.59
	1234.34	97.9714		35.7534	1386.43
	1241.27	169.749		2.99999	3184.10

Sen:	Time	AZ	Sat:	EL	Range
	1225.27	6.06869		3.00016	3179.91
	1232.49	285.374		60.6379	1010.23
	1239.72	204.192		3.00017	3183.97

Sen:	Time	AZ	Sat:	EL	Range
	1330.24	323.806		3.00031	3180.50
	1333.04	300.609		5.22924	2966.05
	1335.86	277.266		2.99998	3182.43

Sen:	Time	AZ	Sat:	EL	Range
	1329.44	350.611		3.00013	3180.26
	1335.75	290.187		23.3425	1790.09
	1342.09	229.375		2.99988	3183.88

Sen:	Time	AZ	Sat:	EL	Range
	1330.13	42.4568		2.99998	3180.50
	1335.49	90.5184		13.1126	2340.55
	1340.83	138.382		2.99994	3183.69

Sen:	Time	AZ	Sat:	EL	Range
	1430.36	8.36351		3.00043	3179.59
	1437.63	284.933		70.0520	946.801
	1444.91	200.982		3.00031	3183.77

Sen:	Time	AZ	Sat:	EL	Range

Time	AZ	EL	Range
1510.65	82.4490	2.99995	3182.95
1514.10	53.5260	6.52837	2848.64
1517.54	24.7497	3.00009	3180.22

Sen:	Time	AZ	Sat:	EL	Range
	1534.36	334.149		2.99994	3179.91
	1538.28	300.921		7.78733	2740.02
	1542.21	267.503		3.00012	3182.46

Sen:	Time	AZ	Sat:	EL	Range
	1607.36	149.289		3.00044	3185.00
	1614.50	71.6931		51.2026	1108.87
	1621.64	354.447		2.99982	3179.88

Sen:	Time	AZ	Sat:	EL	Range
	1660.51	68.2975		2.99992	3183.03
	1665.92	116.926		14.3153	2261.21
	1671.30	165.269		2.99996	3179.68

Sen:	Time	AZ	Sat:	EL	Range
	1710.15	207.389		3.00035	3185.10
	1716.47	267.889		21.6339	1865.92
	1722.81	328.691		3.00002	3180.50

Sen:	Time	AZ	Sat:	EL	Range
	1759.63	7.68014		2.99991	3183.69
	1766.94	281.452		72.1981	936.358
	1774.25	194.903		3.00016	3179.64

Sen:	Time	AZ	Sat:	EL	Range
	1813.05	122.186		3.00034	3185.17
	1819.01	66.7961		18.7554	2006.83
	1824.94	11.7240		3.00002	3180.83

Sen:	Time	AZ	Sat:	EL	Range
	1866.00	295.810		2.99987	3183.04
	1869.44	266.902		6.24335	2874.44
	1872.89	237.963		3.00005	3180.95

Sen:	Time	AZ	Sat:	EL	Range
	1913.21	143.744		3.00031	3185.67

1927.00	1.77020	3.00027	3181.19
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Sen:	446	AZ	EL	3	Range
Time		181.937	3.00005		3185.71
1913.08		260.668	49.7703		1128.45
1920.25		339.869	2.99969		3181.07
1927.44					

Sen:	445	AZ	EL	3	Range
Time		203.670	3.00003		3185.81
2015.46		264.408	22.1479		1843.86
2021.79		325.506	3.00014		3181.98
2028.15					

Sen:	456	AZ	EL	3	Range
Time		122.891	3.00048		3185.08
2019.68		65.8825	20.0966		1938.75
2025.76		9.18568	3.00009		3180.50
2031.82					

Sen:	456	AZ	EL	3	Range
Time		181.745	3.00001		3185.72
2119.85		260.799	50.3759		1120.22
2127.03		340.320	3.00112		3180.63
2134.22					

Sen:	449	AZ	EL	3	Range
Time		25.9708	2.99983		3179.31
2356.60		94.8516	30.4375		1531.73
2363.39		163.417	3.00087		3183.03
2370.18					

Sen:	453	AZ	EL	3	Range
Time		128.827	3.00012		3182.19
2412.10		91.7990	8.53204		2681.25
2416.41		54.8784	3.00003		3185.39
2420.71					

Sen:	449	AZ	EL	3	Range
Time		1.63046	3.00077		3178.90
2458.23		291.213	36.7509		1361.13
2465.10		220.383	2.99989		3182.85
2471.99					

Sen:	453	AZ	EL	3	Range
Time		167.443	3.00037		3180.72
2511.46		77.0045	85.6448		900.327
2518.79		347.556	3.00128		3185.80
2526.11					

Sen:	449		Sat:	3	
Time		AZ	EL		Range
2564.00		319.805	3.01737		3177.87
2565.21		309.986	3.40861		3139.15
2566.43		300.067	3.01688		3178.63
Sen:	446		Sat:	3	
Time		AZ	EL		Range
2566.20		41.1507	3.00015		3180.24
2571.83		92.3541	14.8654		2227.24
2577.43		143.323	3.00000		3183.21
Sen:	453		Sat:	3	
Time		AZ	EL		Range
2614.72		198.072	3.00029		3180.87
2619.68		241.657	11.8201		2430.28
2624.66		285.475	3.00031		3184.90
Sen:	445		Sat:	3	
Time		AZ	EL		Range
2668.69		25.1155	3.00092		3179.98
2675.67		98.1640	37.2111		1351.34
2682.63		170.811	3.00043		3183.29
Sen:	446		Sat:	3	
Time		AZ	EL		Range
2666.61		5.54247	2.99972		3179.52
2673.81		285.632	58.3028		1030.55
2681.02		205.195	3.00043		3183.18
Sen:	445		Sat:	3	
Time		AZ	EL		Range
2770.81		349.930	3.00004		3179.79
2777.06		290.426	22.4594		1827.71
2783.33		230.532	3.00074		3183.03
Sen:	446		Sat:	3	
Time		AZ	EL		Range
2771.77		322.051	3.00023		3180.05
2774.33		300.917	4.83824		3001.95
2776.91		279.645	3.00021		3181.65
Sen:	456		Sat:	3	
Time		AZ	EL		Range
2771.38		41.5783	2.99992		3179.97
2776.83		90.7681	13.7039		2300.83
2782.27		139.756	2.99993		3182.96

Sen:	456		Sat:	3	
Time		AZ	EL		Range
2871.70		7.88483	2.99945		3179.28
2878.95		285.203	67.4939		960.723
2886.22		201.970	3.00021		3183.02
Sen:	449		Sat:	3	
Time		AZ	EL		Range
2951.80		84.1148	2.99978		3183.60
2955.39		53.8814	6.87930		2818.36
2958.97		23.7946	2.99978		3180.50
Sen:	456		Sat:	3	
Time		AZ	EL		Range
2975.80		333.110	3.00020		3179.46
2979.57		301.239	7.37378		2774.40
2983.36		269.181	3.00029		3181.70
Sen:	449		Sat:	3	
Time		AZ	EL		Range
3048.66		150.265	3.00063		3185.70
3055.82		72.0111	53.0193		1086.94
3062.98		354.051	2.99998		3180.11
Sen:	453		Sat:	3	
Time		AZ	EL		Range
3101.73		67.0602	3.00048		3182.33
3107.22		116.640	14.8673		2226.09
3112.68		165.919	2.99983		3179.38
Sen:	449		Sat:	3	
Time		AZ	EL		Range
3151.55		208.538	3.00032		3185.80
3157.81		268.166	20.8814		1901.43
3164.10		328.101	2.99975		3180.86
Sen:	453		Sat:	3	
Time		AZ	EL		Range
3200.97		6.68780	3.00116		3182.83
3208.26		281.162	69.5567		949.100
3215.56		195.396	3.00018		3179.34
Sen:	446		Sat:	3	
Time		AZ	EL		Range
3254.28		123.375	3.00011		3185.92
3260.31		67.0680	19.4755		1970.39
3266.32		11.0733	2.99954		3181.21

Time	AZ	EL	Range
3307.87	293.567	3.00021	3182.28
3310.79	266.627	5.79124	2914.51
3314.02	239.674	2.99999	3180.54

Sen:	445	Sat:	3	Range
Time	AZ	EL		
3354.48	144.799	2.99979		3186.47
3361.43	72.7839	38.3638		1327.09
3368.36	1.16271	3.00001		3181.59

Sen:	446	Sat:	3	Range
Time	AZ	EL		
3354.43	182.958	2.99998		3186.46
3361.58	260.875	47.8369		1156.07
3368.75	339.297	2.99973		3181.44

Sen:	445	Sat:	3	Range
Time	AZ	EL		
3456.86	204.855	3.00047		3186.51
3463.13	264.605	21.2688		1884.53
3469.42	324.712	2.99972		3182.50

Sen:	456	Sat:	3	Range
Time	AZ	EL		
3460.93	124.037	3.00013		3185.83
3467.07	66.1717	20.8241		1904.09
3473.19	8.61264	3.00109		3180.69

Sen:	456	Sat:	3	Range
Time	AZ	EL		
3561.20	182.758	3.00056		3186.40
3568.36	261.028	48.4812		1146.58
3575.54	339.796	2.99980		3181.10

Sen:	449	Sat:	3	Range
Time	AZ	EL		
3797.90	25.4679	3.00039		3178.83
3804.73	95.1233	31.5039		1499.11
3811.55	164.475	2.99981		3182.39

Sen:	453	Sat:	3	Range
Time	AZ	EL		
3853.30	130.031	3.00024		3182.67
3857.76	91.5306	9.03491		2641.40
3862.21	53.1547	2.99995		3186.18

Sen:	449	Sat:	3	Range
Time	AZ	EL		
3999.58	1.22086	3.00120		3178.49

3915.27	271.017	30.0000	1007.47
	221.390	3.00031	3182.06

Sen:	453		Sat:	3	
	Time	AZ		EL	Range
	3952.78	167.924		3.00016	3181.17
	3960.11	75.9743		88.5127	898.630
	3967.44	346.572		3.00050	3186.63

Sen:	446		Sat:	3	
	Time	AZ		EL	Range
	4007.46	40.2774		2.99981	3179.70
	4013.17	92.5830		15.5217	2186.49
	4018.86	144.646		2.99993	3182.47

Sen:	449		Sat:	3	
	Time	AZ		EL	Range
	4005.95	314.745		3.03535	3175.73
	4006.50	310.355		3.11383	3167.99
	4007.05	305.888		3.03565	3175.98

Sen:	453		Sat:	3	
	Time	AZ		EL	Range
	4056.11	198.808		2.99979	3181.40
	4060.97	241.359		11.3388	2465.29
	4065.86	284.135		3.00012	3185.59

Sen:	445		Sat:	3	
	Time	AZ		EL	Range
	4109.99	24.4537		3.00096	3179.43
	4117.00	98.3577		38.7340	1316.95
	4124.00	171.867		2.99960	3182.62

Sen:	446		Sat:	3	
	Time	AZ		EL	Range
	4107.95	5.01541		2.99978	3179.04
	4115.13	285.872		56.0563	1052.23
	4122.32	206.200		2.99964	3182.50

Sen:	445		Sat:	3	
	Time	AZ		EL	Range
	4212.19	349.240		3.00027	3179.26
	4218.37	290.668		21.6055	1865.51
	4224.58	231.698		3.00002	3182.33

Sen:	446		Sat:	3	
	Time	AZ		EL	Range
	4213.33	320.077		3.00049	3179.54
	4215.62	301.225		4.45380	3037.74
	4217.93	292.248		3.00099	3180.79

Sen:	456	Sat:	3
Time	AZ	EL	Range
4212.63	40.7251	3.00062	3179.34
4218.18	91.0176	14.3092	2261.22
4223.71	141.106	3.00046	3182.16

1	20	19	14	16	17	0	0	0	0
0	0	0	0						
2	20	19	17	19	19	0	0	0	0
0	0	0	0						
3	12	15	18	18	14	0	0	0	0
0	0	0	0						
4	0	0	0	0	0	0	0	0	0
0	0	0	0						
5	0	0	0	0	0	0	0	0	0
0	0	0	0						
6	0	0	0	0	0	0	0	0	0
0	0	0	0						
7	0	0	0	0	0	0	0	0	0
0	0	0	0						
8	0	0	0	0	0	0	0	0	0
0	0	0	0						
9	0	0	0	0	0	0	0	0	0
0	0	0	0						
10	0	0	0	0	0	0	0	0	0
0	0	0	0						

DRM 1 Contact Summary - NASA Ground Stations

STATION LOCATIONS:

STATION NAME	LAT. DEG.	LONG. DEG.	HEIGHT METERS	MAX. DEG.	MIN. DEG.	BIAS DEG.
BDA3	32.5514	295.3623	73.800	6.400	0.0	0.0
CANG	35.3100	249.1220	675.341	15.000	0.0	0.0
GDSB	35.3100	255.7465	918.700	14.700	0.0	0.0
MIL3	28.5083	279.3066	855.558	18.000	0.0	0.0
			-54.400	18.000	0.400	0.0

GEOMETRIC SUMMARY TABLE

STN	(0.0 DEG) (----- STATION MASK ADS			(----- MAXIMUM ELEVATION			(----- STATION MASK LOS			(0.0 DEG) (TIME IN CONTACT							
	HR	MN	SE.C	HR	MN	SE.C	AZ	EL	RG(KM)	HR	MN	SE.C	HR	MN	SE.C	(MINUTE)	
BDA3	3	13	34.7	3	17	2.0	135.4	6.1	1563.1	3	18	28.1	3	20	29.5	2.0	
CANG	3	16	11.3	3	22	50.0	148.0	17.3	1925.3	4	56	10.5	4	57	17.0	6.4	
GDSB	4	48	10.3	5	31	5.8	113.5	2.8	1592.5	5	37	16.6	4	1	1277.9	6.2	
MIL3	5	30	21.3	6	10	4.8	169.7	1.0	2027.0	6	13	51.6	10.1	15	23.1	3.6	
BDA3	6	11	53.9	6	12	53.9	202.1	-0.4	1841.0	6	13	50.4	5.8	15	46.4	1.9	
CANG	6	11	53.9	6	12	53.9	179.9	4.4	1548.1	6	13	50.4	5.8	15	46.4	1.9	
GDSB	6	24	19.4	6	25	53.4	241.8	7.2	1446.1	6	28	48.0	18.2	6	33	23.0	6.4
MIL3	7	43	15.7	7	43	55.0	225.0	2.3	1575.8	7	48	5.0	151.6	80.2	13.9	5.9	
BDA3	7	46	56.7	7	47	1.4	241.0	0.3	2111.4	7	51	57.0	153.9	43.3	0.0	9.9	
CANG	7	46	56.7	7	47	1.4	241.0	0.3	1494.9	8	47	24.0	146.5	2.3	1900.2	8.6	
GDSB	8	42	31.2	8	45	6.1	276.3	14.2	1079.3	8	50	22.0	70.8	10.0	1597.0	5.3	
MIL3	9	15	20.2	9	20	7.7	262.9	2.7	1866.9	9	28	45.5	66.4	1.7	1901.3	8.6	
BDA3	9	23	15.9	9	23	17.6	267.5	0.1	2133.9	9	33	42.2	91.5	0.0	2331.6	10.4	
CANG	10	18	27.5	10	20	50.6	283.1	7.6	1457.7	10	26	14.3	33.2	7.9	1433.7	5.4	
GDSB	10	58	19.7	10	59	47.8	287.4	2.6	1876.8	10	58	27.0	158.0	18.5	1936.2	6.5	
MIL3	10	58	19.7	10	57	0.5	287.4	2.6	1876.8	11	1	5	23.0	171.1	1.8	8.4	
BDA3	10	59	47.8	10	59	47.8	280.1	0.0	2339.3	11	9	59.3	98.3	0.0	2241.6	10.2	
CANG	11	56	44.0	11	58	40.8	317.8	2.8	1833.0	11	56	34.9	346.9	13.6	1931.2	2.2	
GDSB	11	56	44.0	11	58	40.8	317.8	2.8	1833.0	12	31	58.7	99.8	13.6	1871.3	6.7	
MIL3	12	32	57.7	12	33	36.6	293.9	2.5	1897.5	12	42	7.3	92.9	2.7	1875.3	9.4	
BDA3	12	36	17.6	12	36	17.6	277.4	0.0	2350.8	12	45	42.9	127.2	0.2	2075.4	9.4	
CANG	14	0	57.9	14	3	29.6	244.4	13.7	1105.2	14	9	9.8	102.9	7.4	1441.1	5.7	
GDSB	14	9	45.8	14	10	53.6	232.5	0.3	1857.0	14	18	20.0	128.7	3.0	1790.2	8.5	
MIL3	14	13	45.0	14	16	59.0	213.1	5.2	2073.0	14	18	20.0	128.7	3.0	1790.2	5.0	
BDA3	14	13	45.0	14	16	59.0	213.1	5.2	2073.0	15	45	36.1	133.0	4.6	1643.4	6.1	
GDSB	15	37	25.1	15	39	29.4	215.8	9.1	1343.9	15	45	36.1	133.0	4.6	1643.4	6.1	
MIL3	15	47	45.0	15	50	13.0	215.4	4.7	1838.5	15	51	59.3	189.9	2.9	1802.4	3.7	
GDSB	17	14	45.0	17	16	15.0	236.0	3.3	1774.7	17	19	15.9	191.4	4.0	1706.5	18.0	

DRM 2 Contact Summary - NASA Ground Stations

STATION LOCATIONS:

STATION NAME	LAT. DEG.	LONG. DEG.	HEIGHT METERS	MAX. DEG.	MIN. DEG.	BIAS DEG.
BDA3	32.3514	295.3423	32,600	6.400	0.0	0.0
CANB	-35.4051	149.3224	15,000	1.000	0.0	0.0
GDSB	25.3416	918.700	16,700	1.900	0.0	0.0
MIL3	25.7485	625.558	16,000	4.000	0.0	0.0
MIL5	29.5003	279.3066	-54,400	18.000	0.400	0.0

GEOMETRIC SUMMARY TABLE																									
(0.0 DEG)		STATION MASK AOS			STATION MASK LOS			STATION MASK ELEVATION					(0.0 DEG)		TIME IN CONTACT (MINUTE)										
STN	MAHE	HR	MS	SE	HR	MS	SE	AZ	EL	RG(KM)	HR	MS	SE	AZ	EL	RG(KM)	HR	MS	SE	AZ	EL	LOS	TIME IN CONTACT (MINUTE)		
BDA3	0	3	20.4	0	4	53.9	176.6	6.0	2892.5	0	11	24.0	258.8	59.3	1026.5	0	15	56.7	336.7	16.4	2154.8	0	19	33.3	11.0
CANB	0	3	27.7	0	5	35.2	39.8	8.3	2688.3	1	22	14.0	109.0	40.2	1287.4	1	59	17.6	137.2	0.4	3275.2	1	10	16.9	12.7
GDSB	1	50	42.7	1	54	42.7	91.3	0.0	3508.3	1	54	6.0	276.7	5.7	2923.7	2	50	17.6	211.4	3.4	3474.5	1	59	2.8	8.3
MIL3	1	49	13.1	2	36	59.9	359.0	1.4	3327.7	2	43	55.0	273.9	24.1	1757.8	2	50	17.6	211.4	3.4	3350.7	2	51	21.8	13.3
MIL5	2	36	33.8	3	27	22.0	154.5	0.0	3494.4	3	35	21.0	75.0	55.4	1064.5	3	41	11.7	355.6	4.5	3050.8	3	43	28.6	14.8
GDSB	3	29	33.3	3	30	27.7	229.4	1.6	3326.5	3	35	42.0	65.7	12.0	2170.6	5	21	34.7	325.0	0.7	3436.4	3	44	51.6	11.5
MIL3	5	10	27.1	5	16	40.3	114.6	0.0	3453.8	5	16	19.0	267.5	19.5	2978.8	5	21	40.5	343.5	0.4	3715.9	5	24	45.2	11.0
MIL5	5	18	33.7	5	19	40.3	117.3	4.7	3051.8	5	21	34.0	57.0	5.8	2933.8	5	24	43.0	332.5	3.4	3482.2	5	26	17.3	14.7
GDSB	6	53	55.8	6	55	14.5	152.6	5.0	2883.9	7	1	57.0	72.5	56.7	1051.5	7	8	53.2	354.7	4.1	3044.2	7	9	59.3	13.6
MIL3	6	54	27.5	6	56	20.6	250.2	2.5	3231.1	8	43	52.0	270.7	4.1	3078.2	7	1	23.3	291.1	2.3	3276.8	7	3	9.4	15.0
GDSB	8	24	58.6	8	38	8.9	218.9	3.5	2491.0	8	43	52.0	268.3	16.9	2114.8	8	49	40.8	327.7	2.8	3121.4	8	50	48.3	11.5
MIL3	10	51	23.0	10	59	3.6	102.6	9.0	2441.7	10	59	3.6	102.6	9.0	2585.6	10	59	30.0	123.1	4.4	3032.2	11	3	22.0	2.4
MIL5	12	31	38.9	12	34	27.4	14.2	12.1	2425.1	12	39	57.0	133.7	82.0	204.7	12	46	24.4	191.9	5.9	2880.0	12	47	54.6	11.9
CANB	13	25	27.2	13	26	10.8	157.3	13.3	3235.2	14	25	40.0	300.2	10.7	1573.3	14	39	77.0	19.9	5.9	2915.5	14	40	45.0	12.3
BDA3	14	14	9.4	14	23	35.2	11.0	0.0	3523.5	14	25	31.0	85.9	33.6	1244.8	14	22	28.6	279.6	12.7	2369.8	14	27	6.4	12.7
GDSB	14	23	39.4	14	27	36.4	181.0	2.7	3224.4	15	14	42.0	247.9	33.6	1480.0	15	14	52.5	175.3	2.2	3492.3	15	22	20.8	13.9
MIL3	16	0	9.6	16	0	25.1	19.8	0.9	3415.5	16	8	11.0	99.1	46.4	1175.1	16	14	52.5	175.3	4.2	3020.8	16	16	40.7	14.5
MIL5	16	1	33.8	16	4	9.4	45.6	1.5	3348.2	16	54	37.0	235.2	10.0	2207.3	16	15	11.3	138.8	1.2	3347.3	16	16	44.1	11.0
GDSB	17	42	19.5	17	42	19.5	353.5	0.0	3515.4	17	49	22.0	229.8	20.1	1938.7	17	56	19.0	232.0	0.0	3475.7	17	56	22.0	13.7
MIL3	17	43	30.7	17	45	38.4	6.6	0.6	2678.0	17	51	40.0	279.0	60.9	1945.7	17	59	19.0	199.6	1.2	3348.2	17	59	38.9	13.7
GDSB	17	48	52.5	17	48	52.5	NA	NA	3120.1	17	50	12.0	82.5	0.3	1441.9	17	59	45.9	172.1	NA	3048.7	17	51	31.9	13.9
MIL3	19	25	6.6	19	26	9.6	229.2	3.7	3350.6	19	33	14.0	97.9	41.4	2404.1	19	35	20.9	271.3	2.6	3213.1	19	36	24.6	12.4
MIL5	19	27	30.5	19	28	11.3	322.6	4.1	3091.4	21	14	22.0	235.2	20.5	1778.9	21	20	40.1	234.2	13.1	3153.0	21	21	20.2	16.9
GDSB	22	1	7.4	22	1	7.4	118.5	4.3	3057.0	22	30	15.0	63.2	20.5	1799.8	22	33	29.1	244.2	13.1	3259.1	22	33	20.2	13.7
MIL3	23	18	65.5	23	18	65.5	NA	NA	3232.7	23	22	6.0	126.0	2.6	3232.7	23	25	26.3	NA	NA	3048.7	23	25	26.3	13.7

APPENDIX B

RRS CONTACT HISTORIES - AIR FORCE SPACE CONTROL NETWORK

Time	904	AZ	EL	Range
29.1438	00:28	283.873	3.00003	1835.54
32.1085	00:32	214.367	25.4306	738.905
36.0744	00:36	144.768	3.00004	1834.64

8 min

**CONTACT HISTORY
AF SPACE NETWORK**

DRM 1
Alt 350 km
Incl. 33.83°

Time	COOK 900	AZ	EL	Range
82.6952	01:23	188.051	3.00011	1834.27
85.2696	01:25	150.293	7.35013	1475.89
87.8385	01:28	112.611	3.00016	1833.20

5

Time	FALCON 907	AZ	EL	Range
85.7272	01:26	208.717	3.00002	1833.64
88.9692	01:29	158.448	11.6224	1212.00
92.2066	01:32	108.245	2.99997	1832.54

6

Time	BOSS 902	AZ	EL	Range
92.1727	01:32	232.384	3.00005	1832.54
95.6202	01:36	177.573	13.8848	1100.65
99.0672	01:39	122.774	2.99996	1832.46

7

Time	HULA 901	AZ	EL	Range
168.239	02:48	206.036	2.99997	1835.07
171.904	02:52	145.870	17.0122	975.166
175.563	02:56	85.8133	3.00003	1833.86

8

Time	COOK 900	AZ	EL	Range
177.353	02:57	234.446	3.00006	1833.50
181.384	03:01	162.191	30.1233	649.858
185.411	03:05	90.0132	2.99997	1832.36

8

Time	FALCON 907	AZ	EL	Range
181.134	03:01	241.606	3.00008	1832.80
185.099	03:05	172.009	26.3710	717.593
189.062	03:09	102.455	2.99999	1832.37

8

Time	BOSS 902	AZ	EL	Range
188.456	03:08	240.201	3.00005	1832.34
191.598	03:12	191.965	10.8036	1256.25
194.742	03:15	143.700	3.00001	1833.13

7

Time	HULA 901	AZ	EL	Range
197.885	03:19	102.455	2.99999	1832.37

Time		AZ	EL	Range
264.184	04:24	254.568	2.99997	1834.29
268.356	04:28	334.616	44.8861	483.443
272.527	04:33	54.6976	3.00003	1832.74

Sen:		COOK 900		Sat:	1	Range
Time		AZ	EL			
273.601	04:34	261.399	3.00006			1832.59
277.823	04:38	176.031	68.7289			373.596
282.045	04:42	90.8023	3.00001			1832.52

Sen:		FALCON 907		Sat:	1	Range
Time		AZ	EL			
277.392	04:37	256.927	2.99994			1832.32
281.379	04:41	186.410	27.6473			692.858
285.368	04:45	115.900	3.00004			1833.04

Sen:		GUAM 905		Sat:	1	Range
Time		AZ	EL			
347.664	05:48	209.582	3.00010			1834.93
351.508	05:52	144.194	21.1921			841.912
355.348	05:55	78.9215	3.00009			1834.20

Sen:		HULA 901		Sat:	1	Range
Time		AZ	EL			
362.058	06:02	295.838	2.99986			1832.98
365.344	06:05	347.048	11.6616			1209.49
368.628	06:09	38.2503	3.00013			1832.28

Sen:		COOK 900		Sat:	1	Range
Time		AZ	EL			
370.164	06:10	271.833	3.00012			1832.29
374.351	06:14	190.425	52.3747			434.822
378.540	06:19	109.074	2.99997			1833.48

Sen:		FALCON 907		Sat:	1	Range
Time		AZ	EL			
374.149	06:14	253.596	2.99992			1832.65
377.537	06:18	200.143	13.1604			1135.01
380.929	06:21	146.642	2.99997			1834.05

Sen:		GUAM 905		Sat:	1	Range
Time		AZ	EL			
444.058	07:24	260.646	2.99995			1834.47
448.023	07:28	330.238	25.2965			740.887
451.988	07:32	39.8808	3.00003			1833.13

Sen:		HULA 901		Sat:	1	Range
Time		AZ	EL			
470.000	07:11	201.300	2.99997			1832.05

462.759	07:43	1.82549	7.78272	1444.28
465.465	07:45	41.8624	2.99998	1832.65

Sen:	COOK 900		Sat:	1	
	Time	AZ	EL	Range	
	466.997	07:47 263.653	3.00016	1832.89	7
	470.657	07:51 203.582	17.1377	969.946	
	474.322	07:54 143.455	3.00005	1834.64	

Sen:	INDI 904		Sat:	1	
	Time	AZ	EL	Range	
	521.678	08:42 153.768	3.03950	1830.08	1
	521.893	08:42 150.821	3.06309	1827.91	
	522.108	08:42 147.864	3.04014	1830.09	

Sen:	GUAM 905		Sat:	1	
	Time	AZ	EL	Range	
	544.004	09:04 325.362	3.02533	1830.55	2
	545.124	09:05 340.894	3.67320	1770.72	
	546.240	09:06 356.385	3.02486	1830.26	

Sen:	HULA 901		Sat:	1	
	Time	AZ	EL	Range	
	556.560	09:17 319.060	2.99999	1832.63	7
	560.108	09:20 16.2553	14.6698	1066.91	
	563.656	09:24 73.4129	2.99987	1834.21	

Sen:	INDI 904		Sat:	1	
	Time	AZ	EL	Range	
	614.530	10:15 223.663	2.99995	1833.91	8
	618.682	10:19 144.948	41.9568	507.905	
	622.833	10:23 66.3135	2.99983	1834.50	

Sen:	HULA 901		Sat:	1	
	Time	AZ	EL	Range	
	652.722	10:53 299.443	3.00020	1833.64	8
	656.959	10:57 28.0834	79.0243	356.492	
	661.198	11:01 116.191	2.99984	1835.84	

Sen:	INDI 904		Sat:	1	
	Time	AZ	EL	Range	
	711.971	11:52 274.681	2.99991	1834.35	6
	715.174	11:55 324.165	11.1191	1240.25	
	718.379	11:58 13.7089	3.00007	1834.03	

Sen:	HULA 901		Sat:	1	
	Time	AZ	EL	Range	
	750.248	12:30 262.294	2.99997	1835.40	6
	753.315	12:33 215.608	10.1218	1298.49	
	757.382	12:37 140.318	3.00004	1835.84	

Sen:	Time	AZ	Sat:	EL	Range

Sen:	Time	AZ	Sat:	EL	Range

Sen:	Time	AZ	Sat:	EL	Range

Sen:	Time	AZ	Sat:	EL	Range

Sen:	Time	AZ	Sat:	EL	Range

Sen:	Time	AZ	Sat:	EL	Range

Sen:	Time	AZ	Sat:	EL	Range

DRM 2
Alt 900 km
Incl. 33.83°

Sen:	Time	AZ	Sat:	EL	Range

HULA 901		Sat:	EL	2	Range
Time	AZ				
80.4953	01:21	184.140	3.00000		3188.78
85.7546	01:26	141.284	11.0753		2489.35
90.9954	01:31	98.6091	2.99998		3188.36

10

Cook 900		Sat:	EL	2	Range
Time	AZ				
89.4711	01:30	215.884	2.99997		3188.50
96.5439	01:37	151.317	27.4155		1636.47
103.604	01:44	86.9645	2.99999		3187.07

14

FALCON 907		Sat:	EL	2	Range
Time	AZ				
93.3945	01:33	229.046	3.00000		3188.10
100.734	01:41	159.829	34.0086		1433.90
108.066	01:49	90.7711	3.00006		3186.92

16

Boss 902		Sat:	EL	2	Range
Time	AZ				
100.890	01:41	249.139	2.99995		3187.29
108.258	01:48	179.405	35.1375		1404.50
115.625	01:56	109.680	2.99989		3187.33

15

INDI 904		Sat:	EL	2	Range
Time	AZ				
140.998	02:21	249.468	2.99999		3188.68
146.323	02:26	205.981	11.1048		2486.58
151.661	02:32	162.377	3.00000		3187.47

11

HULA 901		Sat:	EL	2	Range
Time	AZ				
186.986	03:07	225.938	2.99995		3188.72
194.704	03:15	147.263	52.5556		1095.34
202.414	03:22	68.9029	3.00006		3187.36

15

Cook 900		Sat:	EL	2	Range
Time	AZ				
197.649	03:18	247.065	3.00001		3187.88
205.449	03:25	165.292	63.3251		991.548
213.247	03:33	83.6712	3.00001		3186.98

15

FALCON 907		Sat:	EL	2	Range
Time	AZ				
201.915	03:22	254.037	3.00002		3187.41
209.635	03:30	175.491	53.9786		1078.01
217.354	03:37	96.9969	3.00003		3187.24

15

Boss

424.041 07:04 197.322 26.7034 1049.19 16
431.791 07:12 117.688 3.00000 3188.40

Sen: **FALCON** Sat: 2
907
Time AZ EL Range
420.570 07:01 267.128 2.99992 3187.09
427.382 07:07 206.513 23.4060 1791.81 13
434.206 07:14 145.726 2.99991 3188.70

Sen: **INDI** Sat: 2
904
Time AZ EL Range
476.481 07:57 195.688 3.00008 3187.20
481.529 08:02 154.892 9.94299 2573.24 10
486.566 08:07 114.190 3.00008 3188.14

Sen: **GUAM** Sat: 2
905
Time AZ EL Range
500.748 08:21 270.644 3.00001 3188.21 14
507.857 08:28 335.818 26.5335 1668.12
514.979 08:35 41.1849 2.99989 3186.98

Sen: **HULA** Sat: 2
901
Time AZ EL Range
517.631 08:38 302.991 3.00007 3186.89 14
524.907 08:45 10.9889 29.4794 1566.35
532.177 08:52 78.8785 3.00006 3188.11

Sen: **COOK** Sat: 2
900
Time AZ EL Range
526.090 08:46 270.717 2.99993 3187.35 14
532.853 08:53 210.778 22.6700 1823.81
539.631 09:00 150.634 3.00014 3189.02

Sen: **FALCON** Sat: 2
907
Time AZ EL Range
532.660 08:53 241.278 2.99999 3188.19 6
535.644 08:56 218.343 5.13026 2982.28
538.636 08:59 195.334 3.00011 3188.93

Sen: **INDI** Sat: 2
904
Time AZ EL Range
583.956 09:44 221.221 3.00008 3187.57 15
591.562 09:52 145.924 42.3642 1248.76
599.154 09:59 70.9464 3.00002 3188.37

Sen: **GUAM** Sat: 2
905
Time AZ EL Range
613.106 10:13 306.098 2.99998 3187.25 11
618.582 10:19 351.073 11.6335 2447.24
624.041 10:27 376.0931 2.99990 3186.98

Time	AZ	EL	Range
1427.48	23:47	202.446	3.00000
1433.69	23:54	149.442	16.9340
1439.89	24:00	96.6290	3.00003

Range
3187.44
2109.08
3186.69

13

Sen: **INDI** 904 Sat: 3
 Time AZ EL Range
 49.7684 00:50 199.548 3.00002 3182.94
 55.8272 00:56 256.368 19.5998 1964.76 12
 61.9142 01:02 313.563 3.00000 3184.70

DRM 3
 Alt= 897 km
 Incl = 98°0

Sen: **LION** 906 Sat: 3
 Time AZ EL Range
 68.9661 01:09 109.305 3.00001 3183.03 12
 74.9383 01:15 53.7939 19.1590 1984.06
 80.8937 01:21 358.517 2.99995 3179.70

Sen: **POGO** 903 Sat: 3
 Time AZ EL Range
 77.4883 01:17 65.7557 3.00006 3180.33 15
 84.6358 01:25 348.342 52.7234 1088.37
 91.7839 01:32 270.893 3.00006 3180.69

Sen: **COOK** 900 Sat: 3
 Time AZ EL Range
 92.4817 01:32 342.803 2.99998 3180.90 11
 97.6019 01:38 297.463 12.6831 2369.83
 102.746 01:43 251.855 3.00000 3184.05

Sen: **HULA** 901 Sat: 3
 Time AZ EL Range
 96.9620 01:37 27.6359 3.00006 3182.34 14
 103.867 01:44 98.8342 34.4842 1419.35
 110.752 01:51 169.625 2.99998 3184.61

Sen: **LION** 906 Sat: 3
 Time AZ EL Range
 168.587 02:49 161.914 3.00006 3184.05 14
 175.911 02:56 73.9052 86.2725 898.702
 183.234 03:03 346.648 3.00001 3179.79

Sen: **POGO** 903 Sat: 3
 Time AZ EL Range
 178.762 02:59 90.7097 3.00003 3180.81 14
 185.915 03:06 13.1095 53.1508 1083.33
 193.067 03:13 295.530 2.99999 3180.25

Sen: **HULA** 901 Sat: 3
 Time AZ EL Range
 200.000 02:16 344.540 3.00000 3180.00

205.245	03:25	288.374	21.1503	1889.94
211.430	03:31	229.779	3.00003	3184.67

Sen:	LION		Sat:	3	
	906				
Time		AZ	EL	Range	
272.360	04:32	217.711	3.00000	3183.89	12
278.379	04:38	273.875	17.9482	2048.50	
284.413	04:44	330.229	3.00010	3180.13	

Sen:	POGO		Sat:	3	
	903				
Time		AZ	EL	Range	
280.077	04:40	120.759	3.00003	3181.35	15
287.354	04:47	37.7870	69.9136	946.329	
294.630	04:55	314.881	3.00003	3179.93	

Sen:	GUAM		Sat:	3	
	905				
Time		AZ	EL	Range	
305.734	05:06	35.8696	3.00002	3183.17	13
312.238	05:12	99.3829	24.8999	1728.05	
318.717	05:19	162.505	2.99997	3184.19	

Sen:	Boss		Sat:	3	
	902				
Time		AZ	EL	Range	
375.463	06:15	112.301	3.00001	3183.89	12
381.216	06:21	59.5956	16.9776	2102.19	
386.948	06:27	7.16313	3.00004	3180.25	

Sen:	POGO		Sat:	3	
	903				
Time		AZ	EL	Range	
381.896	06:22	154.770	3.00010	3181.75	15
389.224	06:29	242.323	74.0149	927.485	
396.554	06:37	330.005	3.00005	3179.75	

Sen:	GUAM		Sat:	3	
	905				
Time		AZ	EL	Range	
407.195	06:47	348.693	3.00011	3182.66	13
413.689	06:53	285.363	26.0181	1684.74	
420.209	07:00	221.570	3.00002	3184.36	

Sen:	Boss		Sat:	3	
	902				
Time		AZ	EL	Range	
474.919	07:55	169.445	2.99992	3184.76	15
482.242	08:02	257.531	78.2974	914.151	
489.568	08:10	345.892	3.00008	3180.34	

Sen:	FALCON		Sat:	3	
	907				
Time		AZ	EL	Range	
480.298	08:00	85.8135	2.99999	3183.37	7
483.905	08:04	55.4653	6.90318	2816.42	
487.511	08:07	25.1000	3.00000	3180.07	

POGO
 903 Sat: 3
 Time AZ EL Range
 484.645 08:05 191.686 2.99999 3181.87
 491.725 08:12 267.033 40.1692 1285.92 14
 498.809 08:19 342.496 3.00012 3179.63

COOK
 900 Sat: 3
 Time AZ EL Range
 579.624 09:40 108.988 2.99996 3184.45
 584.828 09:45 62.7278 13.0196 2347.32 10
 590.007 09:50 16.7367 2.99999 3181.10

BOSS
 902 Sat: 3
 Time AZ EL Range
 580.065 09:40 233.274 3.00003 3184.34 10
 584.825 09:45 274.790 10.1509 2552.76
 589.597 09:50 316.418 2.99994 3181.23

FALCON
 907 Sat: 3
 Time AZ EL Range
 577.187 09:37 152.643 2.99996 3184.92
 584.388 09:49 72.9121 56.8180 1045.63 15
 591.579 09:52 353.635 3.00019 3180.61

POGO
 903 Sat: 3
 Time AZ EL Range
 588.581 09:49 230.873 3.00014 3181.55
 594.977 09:56 292.426 21.9389 1849.39 12
 601.378 10:01 354.061 3.00014 3179.58

INDI
 904 Sat: 3
 Time AZ EL Range
 622.557 10:23 65.5160 2.99998 3184.44
 627.070 10:27 104.567 9.53117 2601.71 9
 631.560 10:32 143.389 3.00009 3182.96

COOK
 900 Sat: 3
 Time AZ EL Range
 678.475 11:18 170.437 3.00005 3185.14 15
 685.793 11:26 258.088 77.5036 916.957
 693.115 11:33 346.058 3.00006 3181.07

FALCON
 907 Sat: 3
 Time AZ EL Range
 680.377 11:20 212.014 2.99996 3184.94 12
 686.423 11:26 268.574 18.4587 2022.50
 692.488 11:32 325.390 2.99987 3181.29

Time	AZ	EL	Range
911.922	15:11	22.1857	2.99986
918.850	15:19	93.7574	34.0044
925.765	15:26	165.078	2.99997

3179.77
1429.92
3183.49

15

Sen: **GUAM** 905 Sat: 3

Time	AZ	EL	Range
984.848	16:25	118.354	2.99996
990.009	16:30	72.5284	12.5593
995.142	16:35	27.0126	2.99990

10

Sen: **PDGO** 903 Sat: 3

Time	AZ	EL	Range
1007.67	16:48	354.191	3.00012
1013.10	16:53	43.0230	13.2157
1018.54	16:58	91.8316	3.00018

10

Sen: **LION** 906 Sat: 3

Time	AZ	EL	Range
1013.66	16:54	8.79296	2.99988
1020.73	17:01	293.461	47.0822
1027.82	17:08	217.748	3.00033

14

Sen: **GUAM** 905 Sat: 3

Time	AZ	EL	Range
1084.08	18:04	180.785	3.00026
1091.24	18:07	259.186	50.2935
1098.42	18:14	338.044	3.00057

10

Sen: **POGO** 903 Sat: 3

Time	AZ	EL	Range
1110.60	18:30	6.82236	2.99985
1117.07	18:37	69.5157	22.9229
1123.53	18:44	132.149	3.00003

14

Sen: **BOSS** 902 Sat: 3

Time	AZ	EL	Range
1123.62	18:44	53.3915	3.00009
1127.07	18:47	82.2800	6.20733
1130.51	18:51	111.160	3.00011

7

Sen: **LION** 906 Sat: 3

Time	AZ	EL	Range
1116.38	18:36	356.130	2.99997
1121.15	18:41	314.586	10.9785
1125.93	18:47	272.877	3.00020

11

Sen: **POGO** 903 Sat: 3

Time	AZ	EL	Range
1117.07	18:37	69.5157	22.9229

1805.78
3181.02

1220.28	20:20	74.8230	42.1217	1247.80	17
1227.37	20:27	171.189	3.00053	3181.20	

BOSS

Sen:	902		Sat:	3	
Time		AZ	EL	Range	
1222.66	20:23	17.5087	3.00002	3180.03	14
1229.92	20:30	99.8003	57.6605	1036.83	
1237.16	20:37	181.812	2.99990	3183.83	

POGO

Sen:	903		Sat:	3	
Time		AZ	EL	Range	
1315.38	21:55	31.0263	2.99994	3179.99	15
1322.71	22:03	119.401	77.0873	916.285	
1330.04	22:10	207.914	3.00019	3181.11	

BOSS

Sen:	902		Sat:	3	
Time		AZ	EL	Range	
1324.96	22:05	356.598	3.00010	3179.87	13
1331.19	22:11	297.436	22.4111	1829.64	
1337.44	22:18	237.946	3.00016	3183.23	

FALCON

Sen:	907		Sat:	3	
Time		AZ	EL	Range	
1327.33	22:07	23.7686	3.00043	3180.34	14
1334.30	22:14	96.5019	36.2819	1373.29	
1341.26	22:21	168.917	2.99980	3183.93	

COOK

Sen:	900		Sat:	3	
Time		AZ	EL	Range	
1331.54	22:12	53.6143	2.99977	3181.60	8
1335.59	22:16	88.0575	7.72116	2747.14	
1339.62	22:20	122.429	2.99994	3183.69	

INDI

Sen:	904		Sat:	3	
Time		AZ	EL	Range	
1388.94	23:08	147.848	3.00027	3183.87	14
1395.76	23:16	78.5611	32.2929	1479.76	
1402.55	23:22	9.78292	2.99997	3185.03	

POGO

Sen:	903		Sat:	3	
Time		AZ	EL	Range	
1417.27	23:37	46.4166	3.00025	3180.20	14
1424.54	23:44	324.151	67.9342	957.168	
1431.81	23:51	241.669	3.00031	3180.72	

LION

Sen:	906		Sat:	3	
Time		AZ	EL	Range	
1415.75	23:36	38.8939	3.02698	3177.93	3
1416.69	23:38	31.2551	3.26127	3154.21	
1417.60	23:39	23.6722	3.02697	3177.47	

FALCON
 Sen: 907 Sat: 3
 Time AZ EL Range
 1429.20 23:49 358.242 3.00005 3180.11 14
 1435.84 23:56 292.419 29.7695 1553.12
 1442.51 24:03 226.190 3.00005 3183.61

COOK
 Sen: 900 Sat: 3
 Time AZ EL Range
 1430.66 23:50 13.1312 3.00022 3180.43 15
 1437.98 23:58 102.130 82.1382 904.900
 1445.30 24:05 191.181 3.00017 3183.93

	COOK	HULA	Boss	POGO	INDI	GUAM	LION	FALCON	
1	5	7	3	0	6	6	0	4	0
0	0	0	0						
2	6	8	4	0	8	8	4	6	0
0	0	0	0						
3	6	4	6	14	4	4	8	5	0
0	0	0	0						
4	0	0	0	0	0	0	0	0	0
0	0	0	0						
5	0	0	0	0	0	0	0	0	0
0	0	0	0						
6	0	0	0	0	0	0	0	0	0
0	0	0	0						
7	0	0	0	0	0	0	0	0	0
0	0	0	0						
8	0	0	0	0	0	0	0	0	0
0	0	0	0						
9	0	0	0	0	0	0	0	0	0
0	0	0	0						
10	0	0	0	0	0	0	0	0	0
0	0	0	0						

Epoch Sensitivity
AF Space Network

DAY 1

Sen: **INDI** 904 Sat: **1**
 Time AZ EL Range
 28.1438 283.873 3.00003 1835.54
 32.1085 214.367 25.4306 738.905
 36.0744 144.768 3.00004 1834.64

Sen: **COOK** 900 Sat: **1**
 Time AZ EL Range
 82.6952 188.051 3.00011 1834.27
 85.2696 150.293 7.35013 1475.89
 87.8385 112.611 3.00016 1833.20

Sen: **FALCON** 907 Sat: **1**
 Time AZ EL Range
 85.7272 208.717 3.00002 1833.64
 88.9692 158.448 11.6224 1212.00
 92.2066 108.245 2.99997 1832.54

Sen: **BOSS** 902 Sat: **1**
 Time AZ EL Range
 92.1727 232.384 3.00005 1832.54
 95.6202 177.573 13.8848 1100.65
 99.0672 122.774 2.99996 1832.46

Sen: **HULA** 901 Sat: **1**
 Time AZ EL Range
 168.239 206.036 2.99997 1835.07
 171.904 145.870 17.0122 975.166
 175.563 85.8133 3.00003 1833.86

Sen: **COOK** 900 Sat: **1**
 Time AZ EL Range
 177.353 234.446 3.00006 1833.50
 181.384 162.191 30.1233 649.858
 185.411 90.0132 2.99997 1832.36

Sen: **FALCON** 907 Sat: **1**
 Time AZ EL Range
 181.134 241.606 3.00008 1832.80
 185.099 172.009 26.3710 717.593
 189.062 102.455 2.99999 1832.37

Sen: **BOSS** 902 Sat: **1**
 Time AZ EL Range
 188.456 240.201 3.00005 1832.34
 191.598 191.965 10.8036 1256.25
 194.742 143.700 3.00001 1833.13

HULA

Time	AZ	EL	Range
264.184	254.568	2.99997	1834.29
268.356	334.616	44.8861	483.443
272.527	54.6976	3.00003	1832.74

Sen:	COOK 900	Sat:	1	Range
Time	AZ	EL		
273.601	261.399	3.00006		1832.59
277.823	176.031	68.7289		373.596
282.045	90.8023	3.00001		1832.52

Sen:	FALCON 907	Sat:	1	Range
Time	AZ	EL		
277.392	256.927	2.99994		1832.32
281.379	186.410	27.6473		692.858
285.368	115.900	3.00004		1833.04

Sen:	GUAM 905	Sat:	1	Range
Time	AZ	EL		
347.664	209.582	3.00010		1834.93
351.508	144.194	21.1921		841.912
355.348	78.9215	3.00009		1834.20

Sen:	HULA 901	Sat:	1	Range
Time	AZ	EL		
362.058	295.838	2.99986		1832.98
365.344	347.048	11.6616		1209.49
368.628	38.2503	3.00013		1832.28

Sen:	COOK 900	Sat:	1	Range
Time	AZ	EL		
370.164	271.833	3.00012		1832.29
374.351	190.425	52.3747		434.822
378.540	109.074	2.99997		1833.48

Sen:	FALCON 907	Sat:	1	Range
Time	AZ	EL		
374.149	253.596	2.99992		1832.65
377.537	200.143	13.1604		1135.01
380.929	146.642	2.99997		1834.05

Sen:	GUAM 905	Sat:	1	Range
Time	AZ	EL		
444.058	260.646	2.99995		1834.47
448.023	330.238	25.2965		740.887
451.988	39.8808	3.00003		1833.13

Sen:	HULA 901	Sat:	1	Range
Time	AZ	EL		
444.058	260.646	2.99995		1834.47
448.023	330.238	25.2965		740.887
451.988	39.8808	3.00003		1833.13

462.759
465.465

1.82549
41.8624

7.78272
2.99998

1444.28
1832.65

Sen: **COOK** Sat: 1
900
Time AZ EL Range
466.997 263.653 3.00016 1832.89
470.657 203.582 17.1377 969.946
474.322 143.455 3.00005 1834.64

Sen: **INDI** Sat: 1
904
Time AZ EL Range
521.678 153.768 3.03950 1830.08
521.893 150.821 3.06309 1827.91
522.108 147.864 3.04014 1830.09

Sen: **GUAM** Sat: 1
905
Time AZ EL Range
544.004 325.362 3.02533 1830.55
545.124 340.894 3.67320 1770.72
546.240 356.385 3.02486 1830.26

Sen: **HULA** Sat: 1
901
Time AZ EL Range
556.560 319.060 2.99999 1832.63
560.108 16.2553 14.6698 1066.91
563.656 73.4129 2.99987 1834.21

Sen: **INDI** Sat: 1
904
Time AZ EL Range
614.530 223.663 2.99995 1833.91
618.682 144.948 41.9568 507.905
622.833 66.3135 2.99983 1834.50

Sen: **HULA** Sat: 1
901
Time AZ EL Range
652.722 299.443 3.00020 1833.64
656.959 28.0834 79.0243 356.492
661.198 116.191 2.99984 1835.84

Sen: **INDI** Sat: 1
904
Time AZ EL Range
711.971 274.681 2.99991 1834.35
715.174 324.165 11.1191 1240.25
718.379 13.7089 3.00007 1834.03

Sen: **HULA** Sat: 1
901
Time AZ EL Range
750.248 262.294 2.99997 1835.40
753.315 215.608 10.1218 1298.49
756.382 143.215 3.00005 1834.51

GUAM
905

Time	AZ	Sat:	EL	Range
835.609	340.638		3.00006	1833.80
838.511	24.2306		8.86482	1374.39
841.415	67.8080		3.00006	1835.44

GUAM
905

Time	AZ	Sat:	EL	Range
931.081	304.946		2.99974	1835.08
935.318	33.0911		77.3891	358.960
939.558	120.776		2.99986	1836.87

GUAM
905

Time	AZ	Sat:	EL	Range
1029.09	255.671		3.00015	1836.74
1031.72	216.945		7.56672	1463.74
1034.36	178.162		3.00013	1837.11

INDI
904

Time	AZ	Sat:	EL	Range
1302.40	3.41775		3.00088	1836.89
1304.62	35.2926		5.94412	1584.20
1306.84	67.1459		3.00049	1837.49

BOSS
902

Time	AZ	Sat:	EL	Range
1367.26	182.731		3.00401	1831.60
1369.02	157.816		4.78350	1673.01
1370.78	132.967		3.00424	1831.38

INDI
904

Time	AZ	Sat:	EL	Range
1396.89	305.329		3.00003	1837.58
1401.14	215.666		87.8710	351.461
1405.38	125.932		3.00009	1837.01

BOSS
902

Time	AZ	Sat:	EL	Range
1461.57	223.339		2.99987	1831.73
1464.88	171.526		12.3418	1173.84
1468.19	119.791		3.00011	1832.21

DAY 2

FALCON
907

Time	AZ	Sat:	EL	Range
1455.96	186.481		3.00035	1832.12
1458.26	153.315		6.26719	1554.00
1460.55	120.235		3.00046	1831.71

Time	AZ	EL	Range
1654.48	232.807	3.00031	1833.01
1656.76	199.927	6.22784	1558.79
1659.04	167.022	3.00076	1834.50

Sen:	Time	AZ	EL	Range
	1717.94	182.468	2.99974	1832.82
	1720.61	143.068	7.72416	1448.68
	1723.27	103.733	3.00020	1832.52

Sen:	Time	AZ	EL	Range
	1730.39	279.491	3.00019	1831.75
	1734.11	341.504	17.8277	943.876
	1737.84	43.4604	3.00049	1831.49

Sen:	Time	AZ	EL	Range
	1739.17	269.607	3.00023	1831.63
	1743.39	184.153	67.6963	376.160
	1747.61	99.4442	2.99965	1833.64

Sen:	Time	AZ	EL	Range
	1742.99	257.597	2.99977	1832.30
	1746.75	194.542	19.4583	891.818
	1750.52	131.540	2.99986	1834.66

Sen:	Time	AZ	EL	Range
	1812.78	239.713	2.99971	1832.56
	1817.01	327.386	75.1724	360.846
	1821.24	54.6908	2.99995	1831.71

Sen:	Time	AZ	EL	Range
	1828.62	314.307	2.99995	1831.43
	1831.39	355.563	8.11555	1420.95
	1834.16	36.7749	3.00013	1832.19

Sen:	Time	AZ	EL	Range
	1835.81	269.593	2.99977	1832.64
	1839.82	198.282	28.6637	675.239
	1843.83	127.067	2.99925	1835.49

Sen:	Time	AZ	EL	Range
	1846.45	237.226	3.00013	1834.11

1842.74	207.302	5.63190	1606.58
1844.84	177.332	3.00083	1835.73

Sen:	GUAM 905		Sat:	1	
	Time	AZ	EL	Range	
	1910.96	292.908	2.99993	1831.76	
	1913.82	335.920	8.67237	1383.89	
	1916.69	18.8993	2.99960	1831.34	

Sen:	HULA 901		Sat:	1	
	Time	AZ	EL	Range	
	1925.74	323.056	3.00041	1832.18	
	1928.84	10.4994	10.1388	1294.82	
	1931.94	57.8898	3.00059	1834.16	

Sen:	COOK 900		Sat:	1	
	Time	AZ	EL	Range	
	1933.50	245.338	3.00072	1834.75	
	1935.92	210.134	6.73841	1522.22	
	1938.35	174.885	3.00067	1836.59	

Sen:	INDI 904		Sat:	1	
	Time	AZ	EL	Range	
	1984.12	204.293	2.99968	1832.15	
	1987.68	146.776	15.0275	1050.97	
	1991.23	89.2740	3.00018	1832.37	

Sen:	HULA 901		Sat:	1	
	Time	AZ	EL	Range	
	2021.85	309.135	2.99957	1833.72	
	2025.92	23.5489	31.9398	623.133	
	2030.00	97.7266	3.00058	1836.78	

Sen:	INDI 904		Sat:	1	
	Time	AZ	EL	Range	
	2080.17	250.884	2.99966	1832.26	
	2084.21	323.856	30.6147	641.679	
	2088.26	36.9671	2.99999	1832.01	

Sen:	HULA 901		Sat:	1	
	Time	AZ	EL	Range	
	2118.52	281.342	2.99973	1835.84	
	2122.46	212.820	24.7626	754.736	
	2126.41	144.294	3.00056	1838.31	

Sen:	GUAM 905		Sat:	1	
	Time	AZ	EL	Range	
	2206.01	2.50312	3.02007	1832.37	
	2207.21	19.2720	3.78160	1762.95	
	2208.30	34.0151	3.00034	1833.37	

Sen:	Time	AZ	Sat:	EL	Range
	2300.32	319.758		3.00020	1835.50
	2304.31	29.9282		25.8836	730.503
	2308.29	99.8939		3.00048	1838.35

Sen:	Time	AZ	Sat:	EL	Range
	2396.99	280.659		3.00045	1837.65
	2400.82	215.801		20.7957	855.868
	2404.66	150.898		3.00022	1839.23

Sen:	Time	AZ	Sat:	EL	Range
	2766.21	326.280		2.99933	1839.27
	2770.19	36.1650		26.0029	729.665
	2774.17	105.901		3.00098	1839.52

Sen:	Time	AZ	Sat:	EL	Range
	2831.19	210.624		2.99984	1830.26
	2834.16	165.625		9.55239	1327.60
	2837.13	120.735		2.99966	1831.14

Sen:	Time	AZ	Sat:	EL	Range
	2863.01	274.662		3.00028	1839.93
	2866.72	213.616		17.4330	963.778
	2870.43	152.460		2.99956	1838.62

Sen:	Time	AZ	Sat:	EL	Range
	2916.74	198.099		3.00064	1830.17
	2919.76	152.049		9.89336	1306.62
	2922.78	106.126		2.99989	1830.16

Sen:	Time	AZ	Sat:	EL	Range
	2926.66	235.016		2.99976	1830.65
	2930.12	179.906		14.0171	1094.02
	2933.58	124.914		3.00124	1832.65

Sen:	Time	AZ	Sat:	EL	Range
	2920.02	215.567		2.99998	1830.09
	2923.47	160.524		13.9370	1096.55
	2926.92	105.631		2.99972	1830.70

DAY 3

Sen:		COOK 900		Sat:	1	Range
Time	AZ	EL				
3011.84	239.974	3.00081				1829.88
3015.94	164.242	36.2392				564.035
3020.03	88.8646	2.99981				1831.02

Sen:		HULA 901		Sat:	1	Range
Time	AZ	EL				
3002.54	215.049	3.00025				1830.53
3006.45	146.997	24.0465				766.476
3010.36	79.1340	2.99978				1830.00

Sen:		Boss 902		Sat:	1	Range
Time	AZ	EL				
3023.10	239.304	3.00048				1831.95
3026.08	194.218	9.60245				1326.99
3029.06	149.178	3.00077				1834.58

Sen:		FALCON 907		Sat:	1	Range
Time	AZ	EL				
3015.65	245.294	3.00060				1830.11
3019.64	174.249	28.1946				681.870
3023.64	103.483	3.00050				1832.15

Sen:		HULA 901		Sat:	1	Range
Time	AZ	EL				
3098.91	261.868	2.99971				1830.02
3102.98	336.551	32.4177				613.266
3107.05	51.0555	2.99991				1830.07

Sen:		COOK 900		Sat:	1	Range
Time	AZ	EL				
3108.19	264.323	2.99969				1830.26
3112.41	177.701	71.2899				367.552
3116.64	92.6700	3.00037				1832.80

Sen:		FALCON 907		Sat:	1	Range
Time	AZ	EL				
3111.97	257.766	3.00007				1831.08
3115.92	188.646	25.6379				732.787
3119.87	119.757	3.00031				1834.34

Sen:		GUAM 905		Sat:	1	Range
Time	AZ	EL				
3182.02	218.518	2.99958				1830.58
3186.07	144.859	31.7863				622.646
3190.12	71.3502	3.00009				1829.85

Sen:		HULA 901		Sat:	1	Range
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Time	AZ	EL	Range
3196.95	301.867	3.00061	1829.75
3200.06	349.462	10.1807	1289.77
3203.16	36.9706	2.99989	1830.97

Sen:	COOK 900	AZ	EL	1	Range
Time					
3204.76	271.842	3.00005			1831.47
3208.92	192.489	45.0383			482.168
3213.08	113.657	3.00072			1835.25

Sen:	FALCON 907	AZ	EL	1	Range
Time					
3208.88	250.649	3.00033			1833.17
3212.03	202.201	10.8677			1254.56
3215.19	153.771	2.99922			1836.49

Sen:	GUAM 905	AZ	EL	1	Range
Time					
3278.92	269.356	3.00004			1829.92
3282.66	331.732	18.2042			929.671
3286.39	34.0732	3.00027			1829.56

Sen:	HULA 901	AZ	EL	1	Range
Time					
3294.74	323.214	3.00085			1830.86
3297.50	4.39053	8.08907			1422.97
3300.27	45.4910	3.00006			1833.17

Sen:	COOK 900	AZ	EL	1	Range
Time					
3301.74	260.011	3.00028			1833.87
3305.17	205.476	13.6898			1112.33
3308.62	150.979	2.99971			1837.51

Sen:	INDI 904	AZ	EL	1	Range
Time					
3354.51	179.092	3.00100			1830.82
3356.58	149.511	5.48995			1613.83
3358.65	119.889	3.00178			1830.50

Sen:	HULA 901	AZ	EL	1	Range
Time					
3391.06	316.686	3.00071			1832.79
3394.79	18.5196	17.6578			952.233
3398.51	80.1522	2.99973			1836.80

Sen:	INDI 904	AZ	EL	1	Range
Time					
3312.05	271.177	3.00041			1830.58

3453.27	144.801	71.6442	386.544
3457.49	57.8987	2.99951	1830.07

Sen:	HULA 901	Sat:	1
Time	AZ	EL	Range
3487.31	294.921	3.00004	1835.39
3491.55	208.823	68.8669	375.109
3495.78	123.832	3.00009	1839.54

Sen:	INDE 904	Sat:	1
Time	AZ	EL	Range
3547.24	287.300	3.00000	1830.03
3549.78	324.530	7.13665	1487.45
3552.31	1.79641	2.99940	1829.62

Sen:	HULA 901	Sat:	1
Time	AZ	EL	Range
3585.44	251.396	3.00063	1838.87
3587.85	216.465	6.64921	1532.80
3590.26	181.499	3.00043	1840.54

Sen:	GUAM 905	Sat:	1
Time	AZ	EL	Range
3669.88	334.353	3.00096	1835.20
3673.19	26.0647	11.9273	1199.62
3676.50	77.6456	3.00054	1838.80

Sen:	GUAM 905	Sat:	1
Time	AZ	EL	Range
3765.67	298.639	3.00116	1837.69
3769.90	213.505	64.7010	387.013
3774.13	129.058	3.00068	1840.97

Sen:	GUAM 905	Sat:	1
Time	AZ	EL	Range
3864.70	239.343	3.00670	1840.35
3866.29	217.134	4.39246	1715.65
3867.88	194.917	3.00721	1840.77

Sen:	INDI 904	Sat:	1
Time	AZ	EL	Range
4136.22	350.343	3.00008	1840.43
4139.23	35.7502	9.55909	1337.05
4142.23	81.0599	3.00058	1841.79

Sen:	BOSS 902	Sat:	1
Time	AZ	EL	Range
4201.23	192.586	3.00048	1828.31
4203.48	159.958	6.15449	1559.51
4205.73	107.422	3.00000	1828.17

APPENDIX C

RRS CONTACT HISTORIES - TDRSS

DRM 1
350 KM 33° INC.

TDRS EAST

<u>AOS</u>	<u>LOS</u>
0:00	0:17
1:00	1:54
2:36	3:30
4:13	5:07
5:50	6:45
7:28	8:24
9:07	10:02
10:45	11:40
12:23	13:17
14:00	14:53
15:36	16:30
17:13	18:08
18:51	19:46
20:29	21:25
22:08	23:03
23:46	24:00 *

TDRS WEST

<u>AID</u>	<u>LOS</u>
0:23	1:17
2:00	2:54
3:37	4:33
5:16	6:12
6:55	7:50
8:33	9:27
10:10	11:03
11:46	12:40
13:23	14:17
15:00	15:55
16:38	17:34
18:17	19:13
19:56	20:50
21:33	22:26
23:09	24:00 *

* Still in view at end of run.

DRM 2
900 KM 33° INC.

TDRS EAST

<u>AOS</u>	<u>LOS</u>
0:00	0:23
1:05	2:12
2:54	4:01
4:44	5:52
6:34	7:44
8:25	9:36
10:18	11:27
12:09	13:17:22
13:59	15:06:37
15:49	16:56
17:38	18:48
19:29	20:40
21:22	22:32
23:14	24:00 *

TDRS WEST

<u>AID</u>	<u>LOS</u>
0:23	1:30
2:12	3:22
4:03	5:14
5:55	7:06
7:48	8:56
9:38	10:46
11:28	12:35
13:17:43	14:26
15:07:45	16:18
16:59	18:10
18:52	20:01
20:43	21:51
22:33	23:40

* Still in view at end of run.

DRM 3
897 KM POLAR

IDRS EAST

<u>AOS</u>	<u>LOS</u>
0:0:0	0:34:4
1:11	2:14
2:54	3:56
4:35	5:40
6:13	10:13
10:33	11:44
12:20	13:24
14:03	15:05
15:44	16:48
17:24	18:33
18:58	22:57
23:27	23:59 *

IDRS WEST

<u>AID</u>	<u>LOS</u>
0:19	1:22
1:59	3:07
3:33	7:31
8:01	9:08
9:46	10:49
11:28	12:31
13:09	14:14
14:47	18:49
19:07	20:19
20:54	21:58
22:37	23:39

* Still in view at end of run.

