CONVERGENCE EFFORT MODIFICATION

npoess

NPOESS PHASE 0 BASELINE CONCEPT TIM

17 March 1995

Prepared for:

NPOESS - IPO

LOS ANGELES, CALIFORNIA
and
SILVER SPRING, MARYLAND

CONTRACT F04701-91-C-0068

Prepared by:

Lockheed
Missiles & Space Company, Inc.
SUNNYVALE, CALIFORNIA
94088-3504

3/15/95

I.14

CONVERGENCE EFFORT MODIFICATION

npoess

NPOESS PHASE 0 BASELINE CONCEPT TIM

Prepared for:

NPOESS - IPO

LOS ANGELES, CALIFORNIA
and
SILVER SPRING, MARYLAND

17 March 1995

CONTRACT F04701-91-C-0068

Prepared by:

Lockheed
Missiles & Space Company, Inc.
SUNNYVALE, CALIFORNIA
94088-3504

3/15/95

TABLE OF CONTENTS

CONVERGENCE EFFORT MODIFICATION

NPOESS PHASE ZERO TIM AGENDA

npoess

0730 - 1700 17 MARCH 1995 SUNNYVALE B-157 EXEC CONF RM

PROGRAM OVERVIEW AND STATUS:	0730-0815	M.G. WHITTEN
SPO LOOK AHEAD FOR LOCKHEED PHASE ZERO:	0815-0830	CAPT VASQUEZ
PHASE ZERO REQUIREMENTS ANALYSIS:	0830-0920	R. KENLEY
EDR UPDATES/RECOMMENDED VALUES:	0920-1045	DR HARDY C. STEINKOPFF
CONSTELLATION SYSTEM ENGINEERING STUDIES AND REFRESH RESULTS:	1045-1105	J. HARRISON
NPOESS PHASE ZERO BASELINE SPACE SEGMENT:	1105-1200	J. CLAPP
LUNCH: B-157 CAFETERIA	1200-1245	
NPOESS PHASE ZERO BASELINE SENSORS:	1245-1430	P. CALLARY
NPOESS PHASE ZERO BASELINE C3 UPDATE:	1430-1520:	R. NELSON
NPOESS PHASE ZERO BASELINE IDPS UPDATE:	1520-1550:	P. TOPPING
LCC COST SUMMARY FOR NPOESS PHASE ZERO BASELINE:	1550-1620:	M.G. WHITTEN
SUMMARY AND ACTION ITEM UPDATE:	1620-1700	CAPT VASQUEZ

3/15/95

PROGRAM OVERVIEW

M.WHITTEN

LMSC PHASE 0 PLANS UPDATE

- DEFINE ALTERNATIVES
- STUDY IMPACTS

NPOESS ALTERNATIVE CONCEPTS

npoess

ALTERNATIVE CONCEPTS			
LOW COST	BASELINE	HIGH COST 1	HIGH COST 2
8-channel Imager (OASIS), μWave Imager, μWave & IR Sounders, & GPS Receiver	LOW COST plus SES(1) Sfc data collection, Search & Rescue, & SBUV/TOMS(2)	BASELINE plus SAR, & Altimeter(3)	BASELINE plus CERES, SeaWiFS(2), Lidar, & MOPITT(3) (CH_4 & CO)

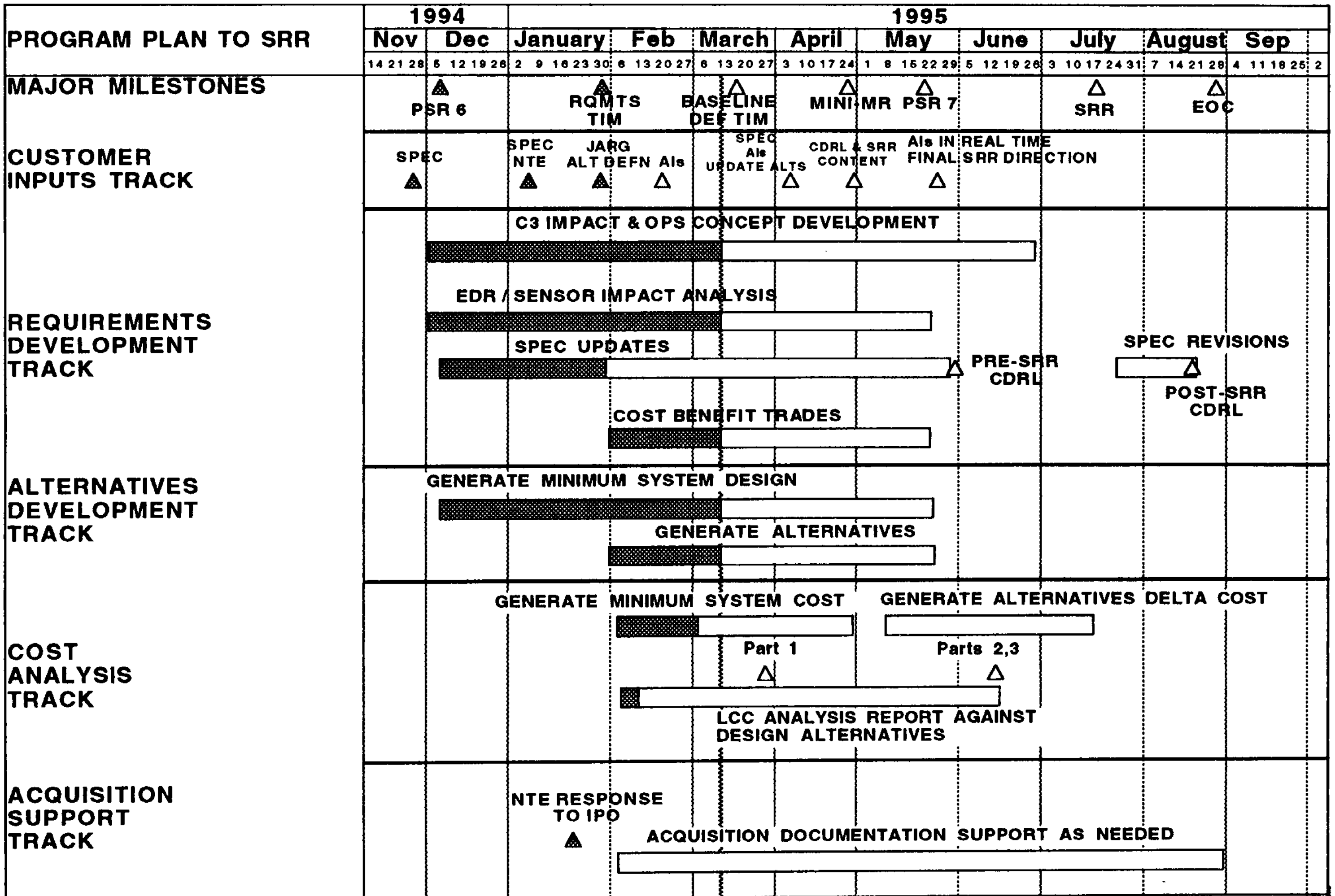
(1) MEPS, NADIS, ABIS, RPAD, HEPS, & VECMAG
(2) On 03 only
(3) Could be on 01 or 03 only

3/15/95

CONVERGENCE EFFORT MODIFICATION

PHASE 0 MILESTONE SCHEDULE

npoess



SUMMARY OF PHASE 0 PLANS UPDATE

npoess

- HOLD SRR DATE AT JULY
  - CDRLS DUE 30 DAYS AFTER SRR & BEFORE END OF PHASE 0 CONTRACT
- MERGE MINIMUM SYSTEM DEFINITION TIM WITH PSR 7 AND MOVE TO THREE DAYS IN MID-MAY
- (*) ADD MINI-MR AT END OF APRIL TO WORK SRR CDRL AND AGENDA ISSUES

  SRR - 7 days prio
  A-Spec - 30 days prio & 30 days after SRR
- CONTRACTORS RECEIVE GOVERNMENT OPS CONCEPT DOCUMENT IN EARLY APRIL WITH RESPONSE DUE BACK AT PSR 7

SUMMARY OF PHASE 0 PLANS UPDATE (CONT'D)

- SYSTEM SPEC WILL BE ONE VOLUME DOCUMENTING REQUIREMENTS FOR BASELINE CONCEPT ONLY
- ALTERNATIVES FOR STUDY AGREED UPON AT 17 MAR TIM
- COMPLETED EDR COST / UTILITY TRADES AT PSR 7
- CLOSE OUT OF CATEGORY I & II REQUIREMENTS ISSUES MUST BE ACHIEVED BETWEEN NOW AND JULY SRR
  - THIS IS AN IMPORTANT METRIC TO UPPER MANAGEMENT IN INDUSTRY AND GOVERNMENT
- BASELINE DEFINITION EMPHASIS

INTEGRATED GOVT-LMSC PLAN (1 OF 3)

npoess

MILESTONE	DATE	PRODUCTS: FROM GOVT TO LMSC	PRODUCTS: FROM LMSC TO GOVT
RQMTS TIM	31 JAN	• JARG STATUS BRIEF ✓ • DEFINITION OF ALTERNATIVES ✓	• SENSING TECHNIQUE FOR ALL EDRS ✓ • RQMTS ISSUES FOR KEY PARAMETERS ✓ • PRELIM SENSITIVITY FOR KEY PARAMS
GOVT INPUT #1	21 FEB	• WRITTEN RESPONSE TO 31 JAN ISSUES ✓ (*IN PROCESS*) • A-SPEC UPDATE (?)	• SAR OPTION FOR SEA ICE ✓
BASELINE CONCEPT DEFN TIM	17 MAR	• APPROVE ALTERNATIVES DESCRIPTION	• INITIAL BASELINE SYS DEFN WITH "BONUS" EDR CAPABILITY DESCRIPTION • SENSITIVITY FOR KEY PARAMS • PRELIM SENSITIVITY FOR OTHER EDRS • PRESENT ALTERNATIVES DESCRIPTION

3/15/95

INTEGRATED GOVT-LMSC PLAN (2 OF 3)

npoess

MILESTONE	DATE	PRODUCTS: FROM GOVT TO LMSC	PRODUCTS: FROM LMSC TO GOVT
GOVT INPUT # 2	6 APR	• WRITTEN RESPONSE TO 17 MAR ISSUES • A-SPEC UPDATE • DRAFT OPS CONCEPT	
MINI-MR (SIT DOWN WITH IPO EAST & WEST)	27 APR	• FINAL SRR CDRL DIRECTION –SYSTEM SPEC CDRL OUTLINE APPROVAL –RISK APPROACH –LCC CDRL –APPROVAL OF SRR AGENDA & CHART TITLES	• SRR PLANNING RECOMMENDATIONS –SYSTEM SPEC CDRL OUTLINE –LCC CDRL OUTLINE & APPROACH –SRR AGENDA & CHART TITLES

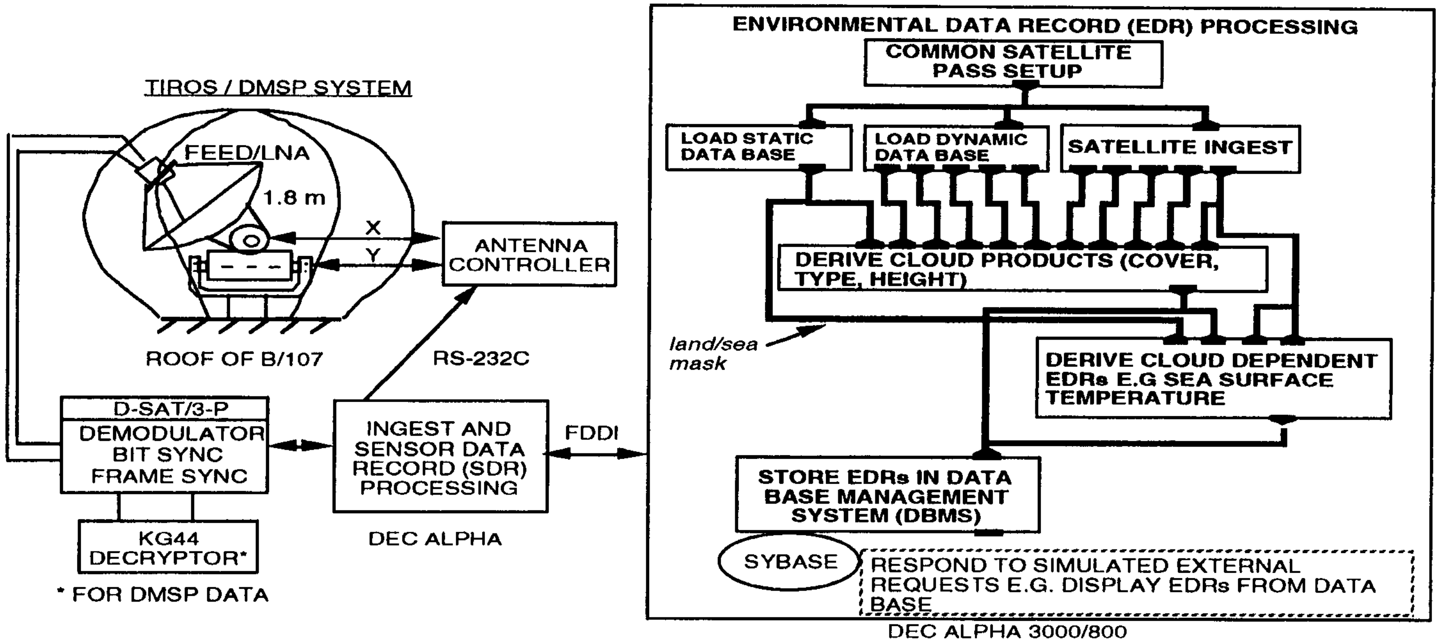
INTEGRATED GOVT-LMSC PLAN (3 OF 3)

MILESTONE	DATE	PRODUCTS: FROM GOVT TO LMSC	PRODUCTS: FROM LMSC TO GOVT
PSR 7	17, 18, 19 MAY	• FINAL DIRECTION FOR SRR • REALTIME RESPONSE TO ACTION ITEMS	• RECOMMENDED BASELINE SYS DEFN • EDR UTILITY / COST TRADES COMPLETE • LOW & HIGH ALTERNATIVE DESIGN CONCEPTS • SENSITIVITY UPDATE TO INCORPORATE HI & LOW OPTIONS • CONTRACTOR UPDATE TO OPS CONCEPT
SRR	18, 19, 20 JUL	• CATEGORY I & II RQMTS ISSUES CLOSED	• SYSTEM SPEC FOR BASELINE SYSTEM • LCC / TRADE DATA

CONVERGENCE EFFORT MODIFICATION

INDEPENDENT DEVELOPMENT PLANS

npoess



FEATURE	BENEFIT
• SATELLITE TO STORED EDR PROCESSING	• IWPTB PROTOTYPE RISK REDUCTION
• STANDARD SATELLITE PROCESSING SEQUENCE	• DIRECT LEGACY FOR DEM/VAL AND TRANSITION
• SHOW ONLY OPERATIONAL USER CONTROL PANELS AND EDR DISPLAYS	• RESULTS SHOWN IN END USER FRAME OF REFERENCE
• PORTABLE DATA BASE MANAGEMENT SYSTEM INTERFACE	• HARDWARE PLATFORM AND COTS SOFTWARE VENDOR INDEPENDENT SOLUTION

3/15/95

LCC APPROACH FOR PHASE 0

- THREE LEVEL DISCLOSURE

1. BASELINE SYSTEM WILL BE COSTED IN DETAIL WITH CARD-LEVEL DESCRIPTION AND DOCUMENTED IN DTC/LCC CDRL-A014 - 16 JUN
2. LIMITED (TBR) ALTERNATIVE DELTA COSTS WILL BE ESTIMATED AND REPORTED IN APPENDIX TO SRR CHARTS / DESIGN REVIEW DATA PACKAGE - 10 JUL
3. OTHER ALTERNATIVES WILL BE COSTED AND REPORTED IN FINAL SRR CHARTS AS APPROPRIATE - 17 JUL

SPO LOOK-AHEAD

J. VASQUEZ

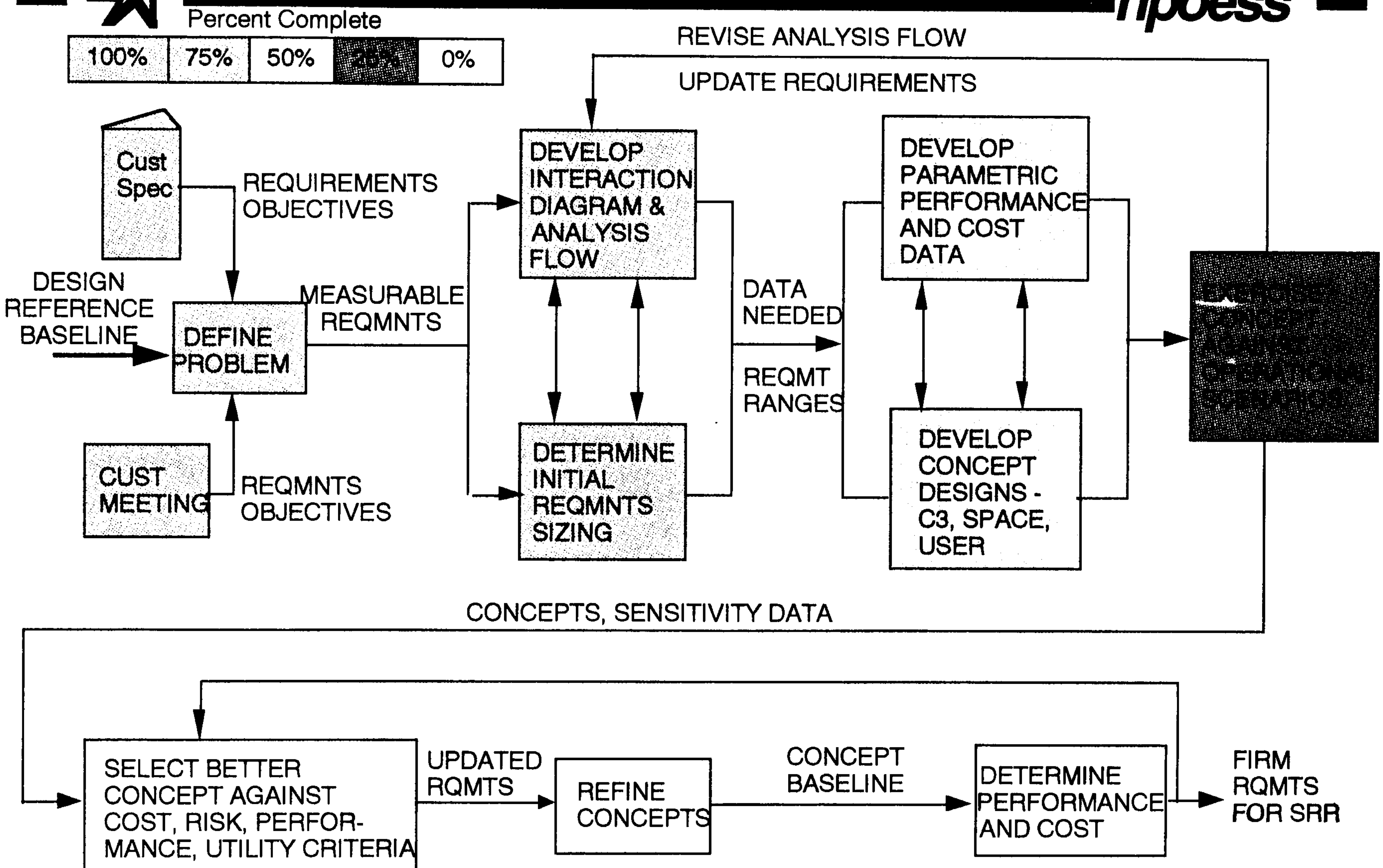
REQUIREMENTS ANALYSIS

R. KENLEY

CONVERGENCE EFFORT MODIFICATION

COMPLETION STATUS FOR LMSC PHASE 0 ANALYSIS AND ITERATIVE TRADES APPROACH

npoess



3/14/95

REQUIREMENTS ISSUES STATUS SUMMARY

NO. OF REQUIREMENTS ISSUES RECEIVED: 91 (2 PLACEHOLDERS/1 DUPLICATE)

NO. OF RI'S WITH LMSC RESPONSES: 87 (NO. 91 STILL IN WORK)

NO. OF RI'S WITH GOV'T RESOLUTION: 12 (ALL OR IN PART)

NO. OF RI'S WITH GOV'T RESOLUTION & LMSC CONCERNS: 6

NO. OF RI'S WITH NO GOV'T RESOLUTION TO DATE: 77

PRIORITY	NO.	NEED DATE
1	23	ASAP
2	52	AS AVAILABLE BEFORE SRR
3	2	DURING DEM/VAL

RI NO. 2 GOVERNMENT RESPONSE CONCERNS

REQUIREMENTS ISSUE NO. 2: DEFINITION OF REFRESH REQUIREMENTS - OPTIMAL (EVENLY SPACED) CASE OR ANY CASE?

GOVERNMENT RESPONSE: USE OPTIMAL (EVENLY SPACED) CASE

LMSC CONCERNS: DO THE WORDS "EVENLY SPACED" REFER TO PLANE SEPARATION ANGLES (ASCENDING NODAL CROSSING TIMES) OR DO THEY ALSO REFER TO PHASING ANGLES?

LMSC APPROACH:

- REFRESH PERFORMANCE (MAXIMUM TIME TO REVISIT) CAPABILITY AGAINST REQUIREMENT WILL BE DETERMINED USING EVEN SPACING IN PLANE SEPARATION AND PHASING ANGLE THAT GIVES OPTIMUM PERFORMANCE.
- WILL REPORT PERFORMANCE FOR THE WORST CASE NON-OPTIMUM PHASING ANGLE TO DOCUMENT MAXIMUM DEGRADATION DUE TO "REAL WORLD" OPERATIONAL CONSIDERATIONS

RI NO. 3 GOVERNMENT RESPONSE CONCERNS

npoess

REQUIREMENTS ISSUE NO. 3: LATITUDINAL EXTENT FOR GLOBAL SEA ICE COVERAGE.

GOVERNMENT RESPONSE: NORTH OF 36 N AND SOUTH OF 50S

LMSC CONCERNS: CAN WE LEAVE A HOLE IN COVERAGE OVER THE ANTARCTICA LAND MASS? SINGLE SIDE-LOOKING SAR MEASURES ALL OF THE NORTHERN POLAR REGION , BUT LEAVES HOLE SOUTH OF 76.8S. MISSES PARTS OF ROSS AND WEDDELL SEAS. IF ALL OF SOUTHERN POLAR REGION IS REQUIRED, MINIMUM OF TWO SATELLITES, EACH WITH A SAR, WILL BE REQUIRED.

LMSC APPROACH:

- **USE ONE SATELLITE WITH A SAR FOR OUR HIGH COST #1 CONFIGURATION AND ALLOW HOLE OVER ANTARCTICA**
- **INVESTIGATE MORE THAN ONE SATELLITE WITH SAR AS PART OF PERFORMANCE PARAMETRICS FOR REFRESH AND COVERAGE REQUIREMENTS.**

RI NO. 3 GOVERNMENT RESPONSE CONCERNS (CONT'D)

npoess

REQUIREMENTS ISSUE NO. 3: LATITUDINAL EXTENT FOR GLOBAL SEA ICE COVERAGE.

GOVERNMENT RESPONSE: NORTH OF 36 N AND SOUTH OF 50S

LMSC CONCERNS: COVERAGE DRIVES SAR DUTY CYCLE TO 51% OF ORBIT. AVERAGE DATA RATE OVER ORBIT FOR SAR BECOMES 7.14 MBPS; TOTAL MISSION DATA RATE INCREASES TO 15.1 MBPS.
IMPACTS ON DESIGN:

- TRIPLE ONBOARD MEMORY
- INCREASE X-BAND SMD TO 200 MBPS
- DOUBLE NUMBER AND COST OF DOMSAT DATA RELAY

LMSC APPROACH: REDUCE IMPACT BY LEAVING HOLE IN ANTARCTIC.

RI NO. 6 GOVERNMENT RESPONSE CONCERNS

npoess

REQUIREMENTS ISSUE NO. 6: NEED CLARIFICATION OF REQUIREMENT FOR 2 HOURS OF PREVIOUSLY IMAGED DATA

GOVERNMENT RESPONSE: DELETE THIS REQUIREMENT FOR PHASE 0.

LMSC CONCERNS: ORIGINAL REQUIREMENT WAS STATED IN TERMS OF DESIGN IMPLEMENTATION. RESPONSE DOES NOT PROVIDE INSIGHT INTO THE MISSION REQUIREMENT.

LMSC APPROACH:

- REQUEST JARG AND USER COMMUNITY REINSTATE REQUIREMENT
- REQUEST FURTHER INFORMATION (IN OPS CONCEPT) FROM GOVERNMENT REGARDING MISSION REQUIREMENT INTENT
- DEVELOP SYSTEM DESIGN IMPACT SENSITIVITIES VS. USER MISSION REQUIREMENT

RI NO. 20 GOVERNMENT RESPONSE CONCERNS

REQUIREMENTS ISSUE NO. 20: WHAT DO USERS MEAN BY HORIZONTAL RESOLUTION FOR IMAGERY AND SOUNDER-DERIVED EDRS? DOES USER WANT TO DISCERN 0.65 km GAPS BETWEEN CLOUDS?

GOVERNMENT RESPONSE: YES, MUST DISCERN BOTH CLOUDS AND GAPS.

LMSC CONCERNS: SIGNIFICANT DEPARTURE FROM PRIOR DEFINITIONS OF HORIZONTAL SPATIAL RESOLUTION. NOT CONSISTENT WITH GOVERNMENT GLOSSARY DEFINITION OF HORIZONTAL SPATIAL RESOLUTION - "For imagery: The diameter of the smallest circle that contains the two dimensional contour on which the system point spread function has half its maximum value."

LMSC APPROACH:

- **REQUEST GOVERNMENT REVIEW AND/OR PROVIDE DEFINITION OF HORIZONTAL SPATIAL RESOLUTION CONSISTENT WITH RESPONSE TO RI#20**

RI NO. 34 GOVERNMENT RESPONSE CONCERNS

npoess

REQUIREMENTS ISSUE NO. 34: DEFINE GLOBAL & REGIONAL RESOLUTION FOR CLOUD IMAGERY. IS REGIONAL DATA REQUIRED AT CENTRAL SITES? HOW MUCH COLLECTED DATA IN ONE ORBIT IS REQUIRED TO BE DOWNLINKED?

GOVERNMENT RESPONSE: GLOBAL REFERS TO LOW RESOLUTION AND REGIONAL REFERS TO HIGH RESOLUTION. REGIONAL RESOLUTION IS REQUIRED AT CENTRAL SITE - COMMANDABLE 25% CONTIGUOUS SECTION OF PREVIOUS ORBIT.

LMSC CONCERNS:

- ANALYSIS SHOWS CLOUD PRODUCTS PERFORMANCE DEGRADES SIGNIFICANTLY AT 2 km RESOLUTION
- 75% OF THE ORBIT WILL HAVE INFERIOR CLOUD PRODUCTS PERFORMANCE

LMSC APPROACH:

- PROVIDE COST-EFFECTIVE CLOUD PRODUCTS PERFORMANCE
- SIZE BASELINE FOR 100% OF THE MISSION DATA TO CENTRAL SITES AT REGIONAL RESOLUTION OF 1.3 km (EDGE OF SCAN) FOR E/O DATA

RI NO. 54 GOVERNMENT RESPONSE CONCERNS

npoess

REQUIREMENTS ISSUE NO. 54: DOES THE IDPS HAVE TO PROCESS EDRS AT THE NON-DOD CENTRAL AND REGIONAL TERMINALS?

GOVERNMENT RESPONSE: NO, ONLY DOD SITES

LMSC CONCERNS:

- AFGWC AND NOAA NESDIS NOT ABLE TO BACK-UP EACH OTHER BECAUSE OF POTENTIAL INCONSISTENT EDR PERFORMANCE
- BOTH NPOESS CONTRACTOR AND NOAA SCIENTISTS DEVELOPING NPOESS EDRS
- TOTAL COST OF CENTRAL AND FIELD SITE NPOESS UPGRADES NOT INCLUDED IN LIFE CYCLE COST

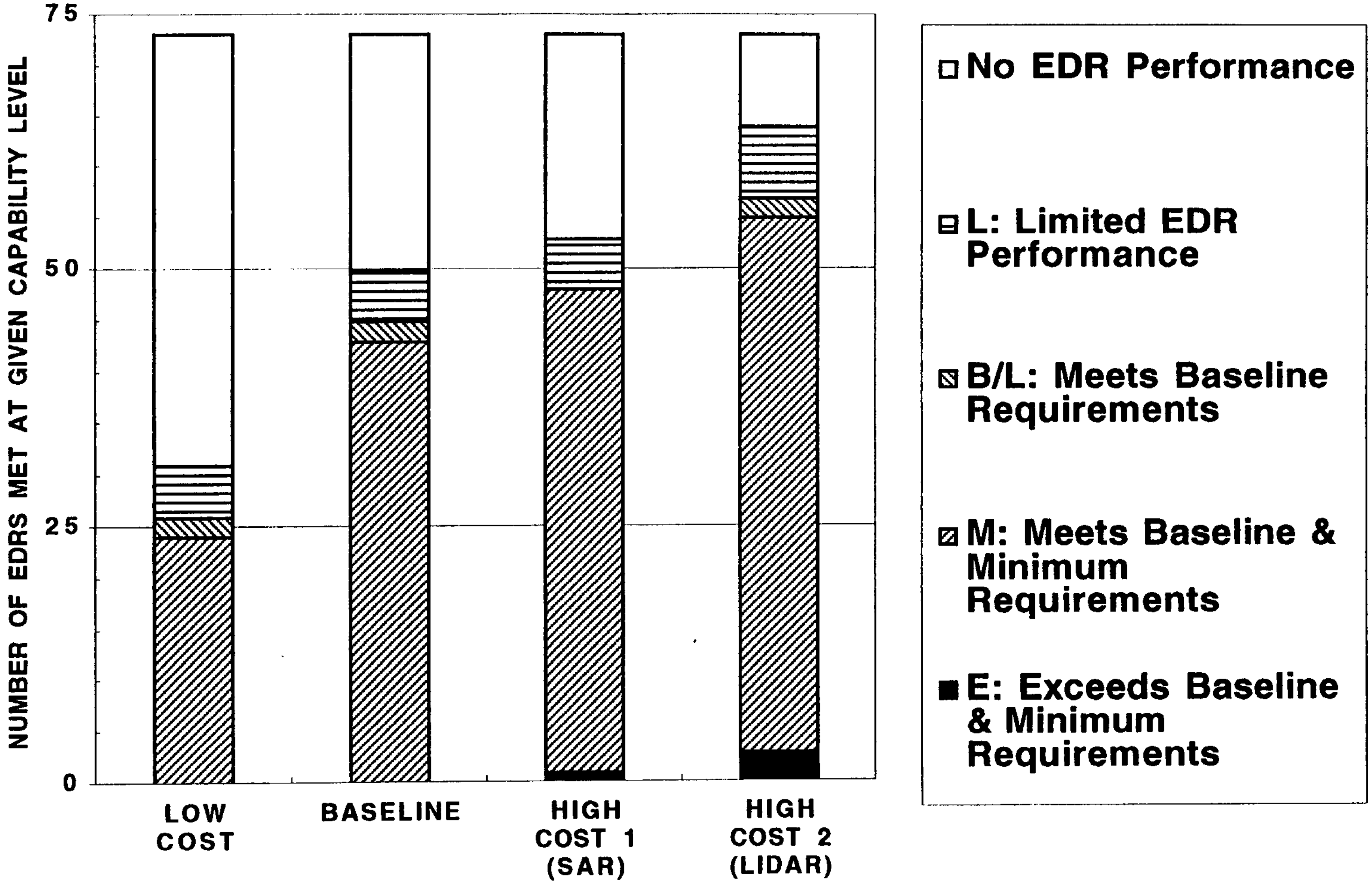
LMSC APPROACH:

- RECOMMEND THAT IDPS HAVE CAPABILITY TO PROCESS EDRS FOR ALL CENTRALS AND REGIONAL TERMINALS

CONVERGENCE EFFORT MODIFICATION

EDR CAPABILITY FOR NPOESS ALTERNATIVES

npoess



3/15/95

EDR UPDATES

K. HARDY &
C.STEINKOPFF

EDR UPDATES

K. HARDY

EDR REQUIREMENTS OVERVIEW

npoess

- EDR ANALYSIS PROCESS
- LIDAR AND SAR FOR EDR MEASUREMENTS
- 4 ALTERNATIVE CONCEPTS DEFINED
  - LOW COST, BASELINE, HIGH COST 1 & 2
- RECOMMENDED EDR ATTRIBUTE VALUES UPDATED
  - ATTRIBUTE VALUES FOR THE 4 ALTERNATIVE CONCEPTS
- SUMMARY OF EDR STATUS
  - ASSESSMENT OF EDR REQUIREMENTS FOR EACH ALTERNATIVE CONCEPT

PROCESS FOR ESTIMATING EDR REQUIREMENTS

- HERITAGE FROM WORK ON EDR DEVELOPMENT
- EXISTING WEATHER SATELLITE SYSTEMS
- INTERACTIONS WITH THE SCIENTIFIC COMMUNITY

• WORK OF THE LOCKHEED SCIENCE TEAM
K. HARDY

- **CLOUDS & AEROSOLS** (K. HUTCHISON)
  - G. LOGAN
- **PROFILERS (IR & μWAVE)** (K. HARDY)
  - T. WILHEIT (TX A & M)
  - P. ROSENKRANZ (MIT)
  - A. HUANG (U. WISC)
- **LAND / OCEAN PARAMETERS** (K. HUTCHISON)
  - R. STEWART (TX A & M)
  - M. DAVIS
  - M. ABBOTT (OSU)
- **SPACE & TRACE GASES** (Y. CHIU)
  - A. ROCHE

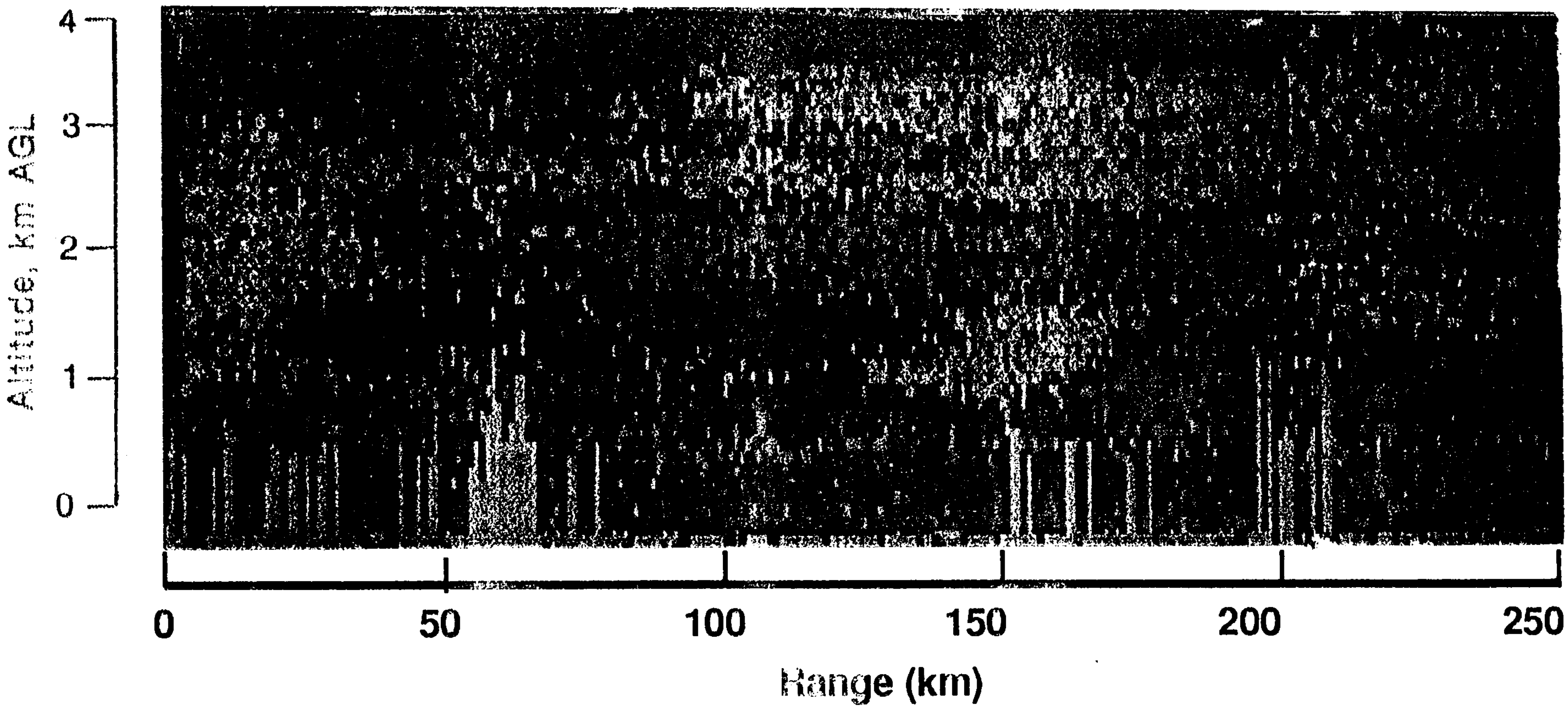
LIDAR MEASUREMENTS FROM SATELLITE

- CLOUDS
  - Top and base of thin clouds, top of highest opaque cloud
  - Optical depth and extinction profile
- TROPOSPHERE
  - Aerosol backscatter cross section, aerosol scattering ratio
  - Height and optical depth of the planetary boundary layer
- STRATOSPHERE
  - Density and temperature profiles, tropopause height
  - Aerosol backscatter cross section, aerosol scattering ratio

CONVERGENCE EFFORT MODIFICATION

SIMULATION OF LIDAR DATA FROM SPACE

npoess



SIMULATED FOR SPACE-BASED LIDAR FROM AIRBORNE LIDAR FLYING OVER THE CARIBBEAN SHOWING:

1. ENHANCED AEROSOL LAYER WITHIN THE BOUNDARY LAYER
2. ELEVATED AEROSOL LAYER AT ABOUT 2 km ALTITUDE, AND
3. LOW AEROSOL CONTENT IN THE UPPER LEFT

(FROM MCCORMICK ET AL: LIDAR IN-SPACE PROGRAM, 1993)

3/15/95

LIDAR AND THE NPOESS EDRs

npoess

EDR	LIDAR HELPS	LIDAR ESSENTIAL
40.8 Aerosol Particle Size		X
40.9 Aerosol Optical Thickness		X (for vert profile)
40.10 Suspended Matter		X (for vert profile)
40.20 Cloud Cover/Layers	X (thin clouds)	
40.21 Cloud Base Height		X
40.22 Cloud Ice, Liquid Eqvlnt		X
40.24 Cloud Ice Water Path		X
40.25 Cloud Optical Depth	X	
40.26 & 28 Cld Top Press, Height	X	
40.46 Neutral Density Profiles	X	

SEA ICE ISSUES

- E-O SEA ICE DATA CAN ONLY BE OBTAINED UNDER CLEAR SKIES, MICROWAVE DATA IS ALL-CLOUDY WEATHER (NO RAIN) BUT AT SUBSTANTIALLY DEGRADED RESOLUTION (12.5 - 50 km).

- SAR REQUIRED FOR 600 m RESOLUTION FOR SEA ICE PARAMETERS UNDER CLOUDY CONDITIONS

- SUGGESTED DEFINITION OF "ICE EDGE BOUNDARY?"

  - ice edge for ice concentration >0%

- ICE CONCENTRATION: 0 OR 10/10 FOR E-O FOOTPRINTS,
  0 TO 10/10 FOR MIS FOOTPRINTS

- ICE THICKNESS: E-O SENSORS PROVIDE SURFACE DETECTION, MICROWAVE FREQUENCIES BELOW 1 GHz OR SAR NEEDED FOR THICKNESS DETERMINATION

- ICE MOTION: TEMPORAL RESOLUTION STRONGLY DEPENDENT
  ON REFRESH AND MAPPING ACCURACY

3/15/95

SEA ICE MEASUREMENTS (1 of 2)

npoess

ICE TYPE	MEASUREMENT TECHNIQUE
NEW ICE: • < 1 m in depth • 10-15 ‰ salinity • low to high emissivity with age • warmer than old ice	OASIS: Detects change in reflectivity between ice and water MIS: Detects change in emissivity from water to ice for ice thickness from 0 to 0.01 m SAR: Detects ice patterns, Detects change in radar scattering from water to ice Primarily surface scatter from the ice
FIRST YEAR ICE: • 1 - 2 m depth • 5-8‰ salinity • lower emissivity • cooler surface temperatures	OASIS: Little or no signature MIS: Usually lower emissivity (lower T_B) than for new ice SAR: Detects larger variance in the surface features Often increased radar cross section

3/15/95

SEA ICE MEASUREMENTS (2 of 2)

npoess

ICE TYPE	MEASUREMENT TECHNIQUE
MULTI-YEAR ICE: • > 2 m in depth • 0.1 - 3 ‰ salinity • often rough surface features • colder than new ice	OASIS: Usually no signature MIS: Detects change in emissivity between first year and multi-year ice SAR: Both surface and volume (sub-surface) scattering Radar cross section tends to increase with ice age due to more prominent surface features

USE INFORMATION FROM OASIS, MIS AND SAR FOR OPTIMUM RETRIEVAL OF ICE CHARACTERISTICS

FOR DETAILS, SEE "NPOESS SEA ICE OPTIONS" PREPARED FOR THE NPOESS IPO ON 23 FEBRUARY 1995

NPOESS ALTERNATIVE CONCEPTS

npoess

ALTERNATIVE CONCEPTS			
LOW COST	BASELINE	HIGH COST 1	HIGH COST 2
1. OASIS (8-channel Imager), 2. μWave Imager, 3. μWave & IR Sounders, & 4. GPS Receiver	LOW COST plus 1. SES(1) 2. Sfc data collection, 3. Search & Rescue, & 4. SBUV/TOMS(2)	BASELINE plus 1. SAR, & 2. Altimeter(3)	BASELINE plus 1. CERES, 2. SeaWiFS(2), 3. Lidar, & 4. MOPITT(3) (CH_4 & CO)

(1) MEPS, NADIS, ABIS, RPAD, HEPS, & VECMAG
(2) On 03 only
(3) Could be on 01 or 03 only

3/15/95

TRADE STUDY FOR SATELLITE-BORNE LIDAR

<table>
<tr><th rowspan="3">LIDAR OPTION</th><th colspan="7">ATMOSPHERIC PARAMETER*</th></tr>
<tr><th rowspan="2">COVER-AGE</th><th colspan="3">AEROSOLS</th><th colspan="3">CLOUDS</th></tr>
<tr><th>OPTICAL DEPTH</th><th>HOR RES</th><th>VERT RES</th><th>OPTICAL DEPTH</th><th>TOP HEIGHT</th><th>DEPOLAR-IZATION</th></tr>
<tr><td>NADIR VIEW LIDAR**</td><td>NADIR ONLY</td><td>5-50%</td><td>1 - 100 km</td><td>0.5 - 2 km</td><td>5 - 50%</td><td>50 m</td><td>20 %</td></tr>
<tr><td>SCAN-NING LIDAR STUDY</td><td>GLOBAL</td><td>5-50%</td><td>1 - 100 km</td><td>0.5 - 2 km</td><td>5 - 50%</td><td>50 m</td><td>20 %</td></tr>
</table>

* BASED ON A "DESIGN STUDY OF A LIDAR SOUNDER FOR SPACECRAFT: AF GEOPHYSICS LABORATORY, 1987

**NADIR-VIEWING LIDAR FOR NPOESS HIGH COST 2 CONCEPT

3/15/95

CONVERGENCE EFFORT MODIFICATION

TRADE STUDY FOR SATELLITE-BORNE LIDAR

npoess

LIDAR OPTION	LIDAR CHARACTERISTICS *							
	TRANSMITTER			RECEIVER			SYSTEM	
	TYPE	PULSE ENERGY	PRF	DIAMETER	EFFICIENCY	FIELD OF VIEW	POWER	WEIGHT
NADIR VIEW LIDAR**	Nd:YAG FREQ-DOUBLED	1J	0.17 Hz	0.5 m	0.84	0.05 to 5 mrad day-night	100W	75 kg
SCANNING LIDAR STUDY	Nd:YAG FREQ-DOUBLED	1J	30 Hz	1.0 m	0.85	0.1 to 5 mrad day-night	~ 1kW	~500 kg

* BASED ON A "DESIGN STUDY OF A LIDAR SOUNDER FOR SPACECRAFT: AF GEOPHYSICS LABORATORY, 1987

** NADIR-VIEWING LIDAR FOR NPOESS HIGH COST 2 CONCEPT

3/15/95

EDRs AND THE 4 ALTERNATIVE CONCEPTS

- FOR EACH EDR, AN ALTERNATIVE CONCEPT MAY:

  1. GIVE NO ESTIMATE OF THE EDR
  2. PROVIDE LIMITED EDR PERFORMANCE
  3. MEET THE LOCKHEED BASELINE REQUIREMENT
  4. MEET THE BASELINE AND THE MINIMUM REQUIREMENTS
  5. EXCEED THE BASELINE AND MINIMUM REQUIREMENTS

- EACH EDR COMES WITH SOME LEVEL OF RISK

  - RISK ESTIMATE INCLUDED IN THE REQUIREMENT TABLES

CONVERGENCE EFFORT MODIFICATION

ALTERNATIVE CONCEPTS AND EDRs

(page 1 of 5)

npoess

L : Limited EDR performance B/L : Meets Baseline Requirements M: Meets Baseline & Minimum Requirements E: Exceeds Baseline & Minimum Requirements	LOW COST	BASE-LINE	HIGH COST 1: (SAR)	HIGH COST 2: (LIDAR)
40.1 *Atmospheric Vertical Moisture Profile	M	M	M	M
40.2 *Atmospheric Vertical Temperature Profile	M	M	M	M
40.3 *Cloud Imagery	M	M	M	M
40.4 *Sea Ice	B/L	B/L	M	B/L
40.5 *Sea Surface Temperature.	M	M	M	M
40.6 *Sea Surface Winds	M	M	E	M
40.7 *Soil Moisture	M	M	M	M
40.8 Aerosol Particle Size				M
40.9 Aerosol Optical Thickness	L	L	L	M
40.10 Suspended Matter	L	L	L	M
40.11 Albedo (Surface).	M	M	M	M
40.12 Auroral Boundary	L	M	M	M
40.13 Optical Backgrounds		M	M	M
40.14 Auroral Imagery		M	M	M

3/15/95

ALTERNATIVE CONCEPTS AND EDRs
(page 2 of 5)

L : Limited EDR performance B/L : Meets Baseline Requirements M: Meets Baseline & Minimum Requirements E: Exceeds Baseline & Minimum Requirements	LOW COST	BASE-LINE	HIGH COST 1: (SAR)	HIGH COST 2: (LIDAR)
40.15 Total Auroral Energy Deposition		M	M	M
40.16 Upper Atmospheric Airglow		M	M	M
40.17 Bathymetry (Deep Ocean and Near Shore)		L	L	L
40.18 Bioluminescence				
40.19 CH4 Column (Methane)				M
40.20 Cloud Cover/Layers	M	M	M	E
40.21 Cloud Base Height	L	L	L	L+
40.22 Cloud Ice, Liquid Equivalent				L
40.23 Cloud Liquid Water	M	M	M	M
40.24 Cloud Ice Water Path				L
40.25 Cloud Optical Depth/Transmittance	L	L	L	L
40.26 Cloud Top Pressure	M	M	M	E
40.27 Cloud Top Temperature	M	M	M	M
40.28 Cloud Top Height	M	M	M	E

CONVERGENCE EFFORT MODIFICATION

ALTERNATIVE CONCEPTS AND EDRs

npoess

L : Limited EDR performance B/L : Meets Baseline Requirements M: Meets Baseline & Minimum Requirements E: Exceeds Baseline & Minimum Requirements	LOW COST	BASE-LINE	HIGH COST 1: (SAR)	HIGH COST 2: (LIDAR)
40.29 CO Column (Carbon Monoxide)				M
40.30 CO2 Column (Carbon Dioxide)				
40.31 Currents				L
40.32 Electric Fields		M	M	M
40.33 Electron Density Profiles/Ionospheric Specification		M	M	M
40.34.1 Supra-thermal/Auroral Particles		M	M	M
40.34.2 Radiation Belt/Low Energy Solar Particles		M	M	M
40.34.3 Solar/Galactic Cosmic Ray Particles		M	M	M
40.35 Fresh Water Ice Concentrations	B/L	B/L	M	B/L
40.36 Geomagnetic Field		M	M	M
40.37 Ice Surface Temperature	M	M	M	M
40.38.1 In-situ Plasma Density		M	M	M
40.38.2 In-situ Plasma Temperature		M	M	M

3/15/95

ALTERNATIVE CONCEPTS AND EDRs
(page 4 of 5)

npoess

L : Limited EDR performance B/L : Meets Baseline Requirements M: Meets Baseline & Minimum Requirements E: Exceeds Baseline & Minimum Requirements	LOW COST	BASE-LINE	HIGH COST 1: (SAR)	HIGH COST 2: (LIDAR)
40.38.3 In-situ Ion Drift Velocity		M	M	M
40.39.1 Ionospheric Scintillation				
40.39.2 In-Situ Plasma Fluctuations		M	M	M
40.40 Land Surface Temperature.	M	M	M	M
40.41 Littoral Sediment Transport				L
40.42 Longwave Radiation				M
40.43 Net Heat Flux	M	M	M	M
40.44 Net Radiation (Top of Atmosphere)				M
40.45 Net Surface Shortwave Radiation				M
40.46 Neutral Density Profiles/Neutral Atmospheric Specification		M	M	M
40.47 Ocean Color/Chlorophyll				M
40.48 Ocean Wave Characteristics			M	
40.49 Ozone Total Column/Profile		M	M	M
40.50 Precipitable Water	M	M	M	M
40.51 Precipitation (Type, Rate)	M	M	M	M

3/15/95

CONVERGENCE EFFORT MODIFICATION

ALTERNATIVE CONCEPTS AND EDRs

(page 5 of 5)

npoess

L : Limited EDR performance B/L : Meets Baseline Requirements M: Meets Baseline & Minimum Requirements E: Exceeds Baseline & Minimum Requirements	LOW COST	BASE-LINE	HIGH COST 1: (SAR)	HIGH COST 2: (LIDAR)
40.52 Pressure (Surface/Profile)	M	M	M	M
40.53 Salinity				
40.54 Sea Surface Height/Topography			M	
40.55 Snow Cover/Depth	M	M	M	M
40.56 Snow Water Equivalent	M	M	M	M
40.57 Solar Extreme Ultra Violet (EUV) Flux				
40.58 Surface Wind Stress	M	M	M	M
40.59 Total Longwave Radiation (Top of Atmosphere)				M
40.60 Total Shortwave Radiation				M
40.61 Total Solar Irradiance (Full Spectrum)				
40.62 Total Water Content.	M	M	M	M
40.63 Tropospheric Winds	M	M	M	M
40.64 Turbidity				M
40.65 Vegetation/Surface Type.	M	M	M	M
40.66 Wave Spectral Energy			M	
Surface Data Collection/Location		M	M	M
Search and Rescue		M	M	M

3/15/95

RISK CRITERIA

- LOW: DEMONSTRATED CAPABILITY FROM SPACE SENSORS
- MEDIUM: SPACE SENSOR FOR EDR BEING DEVELOPED (e g: CERES)
- HIGH:
  1. TECHNIQUES OR SENSORS NEED TO BE DEVELOPED, OR
  2. EXCESSIVE WEIGHT, POWER, AND HIGH COST

CONVERGENCE EFFORT MODIFICATION

npoess

RECOMMENDED EDR ATTRIBUTE VALUES

FOR

THE ALTERNATE CONCEPTS

17 MARCH 1995

npoess

40.1: ATMOSPHERIC VERTICAL MOISTURE PROFILE (Derived) [page 1 of 2]

Moisture profiles (relative and absolute humidity - mass of water vapor per unit volume of air) throughout the troposphere where moisture is normally measured via radiosonde.

Thru-Nadir ±47° [illegible]

Lockheed PI: Dr. Ken Hardy

Solution Type: Conically scanned MIS for low resolution data in cloudy areas. Thru-nadir scanned IR Sounder for high resolution clear areas

Risk: Medium, Devel Reqd

DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS	BASELINE & LOW COST EDR ATTRIBUTE VALUES	REMARKS
Horizontal Spatial Resolution	Minimum: TBD Goal: 10 km	50 km for MIS; 15 km for IR sounder at nadir	IR for clear areas only
Vertical Sampling Interval	Minimum: Measurement of the total water vapor mass shall be in 20 mb increments between Sfc and 850 mb and 50 mb increments between 850 and 100 mb. Goal: 15 mb increments for all layers	FOR MIS: 6 levels: 150 mb intervals between 1000 and 700 mb; 200 mb interval from 700 to 500 mb, and 100 mb intervals from 500 to 300 mb. FOR IR SOUNDER: 20 mb increments between Sfc and 850 mb and 50 mb increments between 850 and 100 mb.	MIS profiles for clear areas and clouds with water content ≤ 0.15 kg/m^2. IR profiles in clear areas only

3/15/95

40.1: ATMOSPHERIC VERTICAL MOISTURE PROFILE (Derived) [page 2 of 2] Moisture profiles (relative and absolute humidity - mass of water vapor per unit volume of air) throughout the troposphere where moisture is normally measured via radiosonde.			Lockheed PI: Dr. Ken Hardy
Solution Type: Conically scanned MIS for low resolution data in cloudy areas. Thru-nadir scanned IR Sounder for high resolution clear areas		Risk: Medium, Devel Reqd	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	**SPECIFICATIONS**	**BASELINE & LOW COST EDR ATTRIBUTE VALUES**	**REMARKS**
Measurement Range		0-100% RH; 0-70 kg/m^2 for total nadir-equivalent columnar water vapor	Added attribute
Mapping Accuracy	Minimum: TBD Goal: 1 km	7 km for MIS and IR Sounder	3σ value
Measurement Uncertainty	Minimum: TBD Goal: ±10% RH		See next two rows
Measurement Accuracy		FOR MIS: ±15% RH over oceans; ±35% RH over land. FOR IR SOUNDER: ±15% RH over oceans; ±25% RH over land.	1σ values. Requirement shall be for RH averaged over 1-km thick layers
Measurement Precision		1% for RH and 0.01 g/kg for Specific Humidity	
Refresh	Minimum: TBD Goal: 3 hrs	11.1 hrs for three satellites (maximum refresh with 81% coverage for sounders)	Depends upon cloud and rain climatology

40.2: ATMOSPHERIC VERTICAL TEMPERATURE PROFILE (Derived) [page 1 of 2]			Lockheed PI: Dr. Ken Hardy
Solution Type: Conically scanned MIS for low resolution data in cloudy areas. Thru-nadir scanned IR Sounder for high resolution clear areas		Risk: Medium, Devel Reqd	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS	BASELINE & LOW COST EDR ATTRIBUTE VALUES	REMARKS
Horizontal Spatial Resolution	Minimum: TBD Goal: 5 km	50 km for MIS; 15 km for IR sounder at nadir	IR profiles for clear area only
Vertical Sampling Interval	Minimum: Sfc - 850 mb, 20 mb increments; 850 - 300 mb, 50 mb incs; 300 -100 mb, 25 mb incs; 100 -10 mb, 20 mb incrs; 10 -1 mb, 2 mb incs; 1 - 0.1 mb, 0.2 mb incs; 0.1 - 0.01, 0.02 mb incs. Goal Intervals: 15 mb inc below 100 mb, TBD above 100 mb	FOR MIS: 16 levels of temperature and geopotential height from sfc to 10 mb. FOR IR SOUNDER: Sfc - 850 mb, 20 mb increments; 850 - 300 mb, 50 mb incs; 300 -100 mb, 25 mb incs; 100 -10 mb, 20 mb incrs; 10 -1 mb, 2 mb incs; 1 - 0.1 mb, 0.2 mb incs; 0.1 - 0.01, 0.02 mb incs.	For non-precipitating areas only. For MIS: clear areas and within and below clouds with water content ≤ 0.15 kg/m^2. For IR sounder: Clear areas over the entire IFOV only
Measurement Range		170 - 330 K	Added Attribute

npoess

40.2: ATMOSPHERIC VERTICAL TEMPERATURE PROFILE (Derived) [page 2 of 2]			Lockheed PI: Dr. Ken Hardy
Solution Type: Conically scanned MIS for low resolution data in cloudy areas. Thru-nadir scanned IR Sounder for high resolution clear areas		Risk: Medium, Devel Reqd	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	**SPECIFICATIONS**	**BASELINE & LOW COST EDR ATTRIBUTE VALUES**	**REMARKS**
Mapping Accuracy	Minimum: TBD Goal: 1 km	7 km	3σ value
Measurement Uncertainty	Minimum: TBD Goal: ±0.5 K		See next two rows
Measurement Accuracy		For MIS: ±5 K for surface, 1000 mb, and tropopause level; ±2.5 K, 925 to 10 mb. For IR Sounder: ±1.25 K for surface to 10 mb; ±3 K 10 mb to 0.01 mb	1σ values applicable for each level IR Sounder accuracy to be confirmed thru simulations
Measurement Precision		±0.5 K	
Refresh	Minimum: TBD, globally Goal: 3 hrs	11.1 hrs for three satellites (maximum refresh with 81% coverage for sounders)	See remarks for Vertical Sampling Interval

3/15/95

3. Cloud Imagery (page 1 of 2)

The capability to generate visible and infrared (IR) imagery in a displayable EDR format shall be provided. Daytime and nighttime visible imagery shall have a minimum apparent transition across the terminator. Striping in the visible/IR derived SDR and EDR imagery due to pixel nonuniformity shall be minimized and shall not affect the utility of the data. Geometrical distortion in the visible/IR imagery shall be minimized and shall not affect the utility of the imager. Absolute calibration of the radiances at all frequencies is required.

The horizontal resolution for processed cloud data (cover, type, and height) is defined by the resolution of the Nephanalysis mesh at the weather central. Current practice is to use a polar stereographic map projection for which each hemisphere is overlaid with a 512 x 512 square grid (called "eighth mesh"), which is true at 60 degrees latitude, i.e., the quoted geographical grid size of the mesh (25nm or 40km) is true at 60 degrees latitude. A future upgrade would be the implementation of a sixteenth mesh (20km) grid.

Imagery must be at sufficient resolution to enable analysts to discern atmospheric phenomena from cloud types to planetary scale (107 m) weather patterns. At a minimum, classification of detected stratus, cirrus, and cumulus clouds is required. The goal for this system is to be able to identify all 18 cloud types as defined in AFI 15-111, Vol. I.

npoess

40.3: CLOUD IMAGERY (Measured) [page 2 of 2]			Lockheed PI: Greg Logan
Solution Type: OASIS			Risk: Low
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS	BASELINE & LOW COST EDR ATTRIBUTE VALUES	REMARKS
Horizontal Spatial Resolution	Minimum: 2.4 km global 0.65 km regional Goal: 0.65 km global TBD regional	0.65 km at nadir and ≤1.3 km at edge of scan global and regional. 3.25 km to 6.5 km for nighttime low-light level sensor	
Mapping Accuracy	Minimum: TBD Goal: 1 km	4 km	3σ value at edge of scan
Refresh (Centrals and Field)	Minimum: 4 hrs Goal: 1 hr	5.5 hrs (maximum refresh with 100% coverage and three satellites)	Based on 3 satellites

3/15/95

SEA ICE ISSUES

- E-O SEA ICE DATA CAN ONLY BE OBTAINED UNDER CLEAR SKIES, MICROWAVE DATA IS ALL-CLOUDY WEATHER (NO RAIN) BUT AT SUBSTANTIALLY DEGRADED RESOLUTION (12.5 - 50 km).

- SAR REQUIRED FOR 600 m RESOLUTION FOR SEA ICE PARAMETERS UNDER CLOUDY CONDITIONS

- SUGGESTED DEFINITION OF "ICE EDGE BOUNDARY?"

  - ice edge for ice concentration >0%

- ICE CONCENTRATION: 0 OR 10/10 FOR E-O FOOTPRINTS,
  0 TO 10/10 FOR MIS FOOTPRINTS

- ICE THICKNESS: E-O SENSORS PROVIDE SURFACE DETECTION, MICROWAVE FREQUENCIES BELOW 1 GHz NEEDED FOR THICKNESS DETERMINATION

- ICE MOTION: TEMPORAL RESOLUTION STRONGLY DEPENDENT ON REFRESH AND MAPPING ACCURACY

3/15/95

npoess

40.4: SEA ICE (page 1 of 3; Derived)	RISK: Low for OASIS & MIS High for SAR	Lockheed PI: Mike Davis

DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		LOW COST & BASELINE		HIGH COST 1
	MINIMUM	GOAL	OASIS	MIS	SAR
Sensing Depth	ice surface	3 m	Ice surface	Ice surface	0.04 to 5 m (ice type)
Horizontal Spatial Resolution					
1. ice edge boundary	600 m	100 m	650 m nadir to 1300 m at edge of scan	12.5 to 50 km	600 m
2. ice concentration	600 m	100 m	650 - 1300 m	12.5 - 50 km	600 m
3. age	1000 m	100 m	N/A	12.5 - 50 km	600 m
4. leads/polynyas	600 m	100 m	650 - 1300 m		600 m
Vertical Sampling Interval 1. ice thickness	TBD	0.2 m	N/A	(new ice only) ≤0.01 m or >0.01 m	1-2 m
Mapping Accuracy	3000 m	1000 m	4000 m	7000 m	60 m

3/15/95

40.4: SEA ICE (page 2 of 3; Derived)	RISK: Low for OASIS & MIS High for SAR	Lockheed PI: Mike Davis

DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		LOW COST & BASELINE		HIGH COST 1
	MINIMUM	GOAL	OASIS	MIS	SAR
Measurement Range					
1. ice edge boundary	600 to 1000 m	100 to 600 m	650 to 1300 m	12.5 to 50 km	600 to 1000 m
2. ice concentration	1/10 to 10/10 cover	0/10 to 10/10 cover	0/10 or 10/10	0/10 to 10/10 cover	0/10 to 10/10 cover
3. age	1 to 36+ mos	TBD	N/A	new or multi-year	1 to 36+ mos
4. ice thickness	TBD	0-25 m	N/A	≤0.01 m or >0.01 m (new ice only)	0-5 m
5. ice motion	600 to 1000 m *(probably 600 to 1000 m/day)*	0 to 100 m	0-2 km/day (clear scenes only)	N/A	600 to 2000 m per refresh period
6. leads/polynyas	600 to 1000 m	100 to 600 m	650-1300 m	12.5-50 km	600 to 1000 m

3/15/95

(((

CONVERGENCE EFFORT MODIFICATION

npoess

40.4: SEA ICE (page 3 of 3; Derived)		RISK: Low for OASIS & MIS High for SAR		Lockheed PI: Mike Davis	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		LOW COST & BASELINE		HIGH COST 1
	MINIMUM	GOAL	OASIS	MIS	SAR
Measurement Uncertainty					
1. ice edge boundary	±10%	±5%	4 km (worst mapping accuracy)	12.5 to 50 km	±10% or 60 m (mapping accuracy)
2. ice concentration	±20%	±10%	±20%	±20%	±10%
3. age	separation of 1 yr old and 2+ yr old ice with 30% area defined correctly	separation of <1 yr old (new) ice, 1 yr old (first year) and 2+ yr old (multi-year) ice with 10% of area defined correctly	N/A	First and multi-year ice with 70% area defined correctly	separation of 1 yr old and 2+ yr old ice with 70% area defined correctly
4. ice thickness	TBD	0.2 m	N/A	new ice: <0.01 or >0.01 m	2 m
5. ice motion	1000 m/day	100 m/day	1000 m/day (clear scenes only)	N/A	600 m/day
6. leads/polynyas	±10%	±5%	4 km	12.5 to 50 km	±10% or 60 m
Refresh	24-48 hrs	Goal: 12 hours	24 hours (clear areas)	24 hours	24-48 hrs

3/15/95

40.5: SEA SURFACE TEMPERATURE (Derived) Temperature of the water at the sea/atmosphere boundary				Lockheed PI: Dr. Keith Hutchison
Solution Type: OASIS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE & LOW COST EDR ATTRIBUTE VALUES	REMARKS
Horizontal Spatial Resolution 1. global 2. coastal	Minimum 4 km TBD	Goal 1 km 0.25 km	 4 km 4 km	
Measurement Uncertainty	Minimum: 0.5° C	Goal: 0.25° C	0.5° C	Uses total integrated water vapor from MIS
Measurement Range	Minimum: TBD	Goal: -2 to 40° C	-2 to 40° C	
Precision	Minimum: TBD	Goal: ±0.1° C	±0.1° C	
Mapping accuracy 1. global 2. coastal	Minimum TBD TBD	Goal: 0.5 km 0.25 km	 4 km 4 km	3σ at edge of scan
Refresh	Minimum: 6 hrs	Goal: 3 hours	8 hours for clear areas, 2 satellites	Depends on cloud coverage

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.6: SEA SURFACE WINDS (Derived) Measure of atmospheric wind speed/direction at the sea/atmosphere interface. Wind speed at the sea surface as a threshold, speed and direction as an objective.				Lockheed PI: Mike Davis
Solution Type: Conically scanned MIS*			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE & LOW COST ATTRIBUTE VALUES	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 1 km	50 km	
Mapping Accuracy 1. global 2. regional	Minimum 30 km global 10 km regional	Goal: 20 km global 1 km regional	 7 km 7 km	
Measurement Uncertainty	Minimum: TBD	Goal: ±10% for speed; ±20 deg for direction	±2 m/s (1 σ) for speed; no directional information	Clear, cloudy, and rain ≤ 2 mm/hr
Precision	Minimum: TBD	Goal: ±1 m/s for speed ±10 deg for direction	±1 m/s for speed no directional measurement	
Refresh	Minimum: 6 hrs	Goal: 1 hr	~8 hours for 2 satellites	No refresh for rain > 10 mm/hr
Measurement Range			*3 to 25 m/s*	*Suggest "Measurement Range "be added*

* NOTE: Additional information on the sea surface and winds obtained from both SAR and a radar altimeter.

3/15/95

40.7: SOIL MOISTURE (Derived) Measure of moisture on (surface) or within (subsurface) soil.				Lockheed PI: Mike Davis
Solution Type: Conically scanned MIS*			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE & LOW COST ATTRIBUTE VALUES	REMARKS
Sensing Depth	Minimum: Surface	Goal: Surface to -80 cm	Surface to 0.1cm	
Horizontal Spatial Resolution	Minimum: TBD	Goal: 2 km	50 km	
Vertical Sampling Interval	Minimum: TBD	Goal: 5 cm	N/A	
Mapping Accuracy	Minimum: TBD	Goal: 1 km	7 km	
Measurement Uncertainty	Minimum: TBD	Goal: ± 1 cm/m^2	± 1.5 cm (API) (assumed to be over a unit area)	Estimate API from μwave brightness temp. Bare soils and vegetation <10 cm only
Measurement Precision			0.5 cm (API)	
Refresh	Minimum: 6 hrs	Goal: 3 hrs	~8 hours for 2 satellites	Worst case with 100% coverage
Measurement Range			*0 to 8 cm (API)*	*"Measurement Range "added*

*NOTE: Improved information on soil moisture obained at radiometer frequencies of 10 and 6.8 GHz.

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.8: AEROSOL PARTICLE SIZE (Derived)			Lockheed PI: Dr. Keith Hutchison	
Solution Type: OASIS, Lidar			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE & LOW COST ATTRIBUTE VALUES	HIGH COST 2: LIDAR
Sensing Depth	Minimum: Sfc to 15 km	Goal: Sfc to 30 km	Possibly strato-sphere or troposphere	Sfc to 15 km for nadir viewing only
Horizontal Spatial Resolution	Minimum: 10 km	Goal: 1 km	10 km	1 km along track
Vertical Sampling Interval	Minimum: 0-2 km, 0.5 km intervals; 2-5 km, 1 km intervals; >5 km, 2 km intervals	Goal: 0-2 km, 0.25 km intervals; 2-5 km, 0.5 km intervals; >5 km, 1 km intervals	Troposphere or stratosphere total column	Minimum: 0-2 km, 0.5 km intervals; 2-5 km, 1 km intervals; >5 km, 2 km intervals
Mapping Accuracy	Minimum: 4 km	Goal: 1 km	4 km	1 km
Measurement Range	Minimum: TBD	Goal: TBD	0.1-10 μm radius*	0.1-10 μm rad*
Precision	Minimum: 0.3	Goal: 0.1	Mean radius < 1 or >1 μm*	Mean radius < 1 or >1 μm*
Measurement Uncertainty	Minimum: 0.3	Goal: 0.1	±2 μm for mean radius*	±2 μm for mean radius*
Refresh	Minimum: 12 hrs	Goal: 4 hrs	~14 hours for 2 satellites	12 hours for nadir view only

*NOTE: Values need confirmation

3/15/95

40.9: AEROSOL OPTICAL THICKNESS (Derived) Vertical visibility			Lockheed PI: Dr. Keith Hutchison	
Solution Type: OASIS			Risk: Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE & LOW COST ATTRIBUTE VALUES	HIGH COST 2: LIDAR
Sensing Depth	Minimum: Sfc to 15 km	Goal: Sfc to 30 km	Sfc to 30 km	Sfc to 30 km
Horizontal Spatial Resolution	Minimum: 10 km	Goal: 1 km	10 km	1 km
Vertical Sampling Interval	Minimum: 0-2 km, 0.5 km intervals; 2-5 km, 1 km intervals; >5 km, 2 km intervals	Goal: 0-2 km, 0.25 km intervals; 2-5 km, 0.5 km intervals; >5 km, 1 km intervals	Total Column, sfc to 30 km	Minimum: 0-2 km, 0.5 km intervals; 2-5 km, 1 km intervals; >5 km, 2 km intervals
Mapping Accuracy	Minimum: 4 km	Goal: 1 km	4 km	1 km
Measurement Range	Minimum: TBD	Goal: 0 - 50 km	0.1 to 2 for visible spectrum*	0.1 to 2 for visible spectrum*
Precision	Minimum: 0.03	Goal: 0.01	0.03*	0.03*
Measurement Uncertainty	Minimum: 0.05 to 0.10	Goal: 0.01 to 0.03	0.1*	0.1*
Refresh	Minimum: 12 hrs	Goal: 4 hrs	~14 hours for 2 satellites	12 hours for nadir view only

*NOTE: Values need confirmation

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.10: SUSPENDED MATTER (Derived)			Lockheed PI: Dr. Keith Hutchison	
Solution Type: OASIS			Risk: Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE & LOW COST ATTRIBUTE VALUES	HIGH COST 2: LIDAR
Horizontal Spatial Resolution	Minimum: TBD	Goal: 1 km	10 km	1 km nadir view only
Vertical Sampling Interval	Minimum: TBD	Goal: 0-2 km,	Stratosphere or troposphere	1 km nadir view only
Measurement Range	Minimum:	Goal		
1. Detect Aerosols	dust, sand, and ash	dust, sand, ash, and sea salt	Dust,sand, & ash	Dust,sand, & ash
2. Radioactive/Smoke Plumes	TBD	0-100$\mu g/m^3$ (smoke)	N/A	N/A
Measurement Uncertainty	Minimum: TBD	Goal: TBD	50% incorrect aerosol type*	50% incorrect aerosol type*
Precision	Minimum: TBD	Goal: TBD	Dust, sand or ash*	Dust, sand or ash*
Mapping Accuracy	Minimum: TBD	Goal: TBD	4 km	4 km
Refresh	Minimum: TBD	Goal: 3 hrs	~14 hours for 2 satellites	12 hours for nadir view only

*NOTE: Values need confirmation

3/15/95

40.11: ALBEDO (SURFACE) (Derived)		Lockheed PI: Dr. Keith Hutchison	
Solution Type: OASIS		Risk: Low	

DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE & LOW COST EDR ATTRIBUTE VALUES	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 0.5 km	1.3 km	Clear areas only
Vertical Sampling Interval	Minimum: TBD	Goal: 1 km	Surface only	Ambiguous "Goal"
Mapping Accuracy	Minimum: TBD	Goal: 10 km	4 km	
Measurement Range	Minimum: TBD	Goal: 0 - 100%	0 - 100%	Band dependent
Precision	Minimum: TBD	Goal: TBD	0.1%	10 bit data
Measurement Uncertainty	Minimum: TBD	Goal: ±1.25%	5%	
Refresh	Minimum: 6 hrs	Goal: 4 hrs	~6 hours for 3 satellites in clear (daytime) areas	Depends on cloud free areas

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.12: AURORAL BOUNDARY (Derived) The boundary of the auroral zone, a roughly oval shaped region at high latitudes in which auroral disturbances occur.*			Lockheed PI: Dr. Yam Chiu	
Solution Type: MEPS, GPSR, ABIS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE EDR ATTRIBUTE VALUES	REMARKS
Coverage	Minimum: Global	Goal Global	MEPS: along track only; ABIS: 100 km cross track; GPSR: 1000 km cross trk	Model reqd to integrate data from various sensors
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	MEPS: 2 km along track; ABIS: 10 km on swath; GPSR: 2-1000 km depending on geometry	Model reqd to integrate data from various sensors
Mapping Accuracy	Minimum: TBD	Goal: 10 km	Better than 10 km (w/GPS)	Model reqd to integrate data from various sensors
Measurement Range	Minimum: TBD	Goal: Global	Global (w/model); along constellation swath without model	Model reqd to integrate data from various sensors
Precision	Minimum: TBD	Goal: 10 km	10 km (along track only)	Impacted by data integration into model
Measurement Uncertainty	Minimum: TBD	Goal: 10 km	10 km (along track only)	Impacted by data integration into model
Refresh	Minimum: 2/orbit	Goal: 15 min	2/orbit (or better) for model	15 min not possible for global coverage

*This is a key parameter in modeling magnetosphere environment

3/15/95

40.13: OPTICAL BACKGROUNDS (Derived)			Lockheed PI: Dr. Yam Chiu	
Solution Type: CVF/IRR			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	**SPECIFICATIONS**		**BASELINE EDR ATTRIBUTE VALUES**	**REMARKS**
Coverage	Minimum: TBD	Goal: Global	Along const. swath only	Global not possible as conditions change rapidly and instrument has very limited FOV and depth of view
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	10 km along track 200 km cross track	
Mapping Accuracy	Minimum: TBD	Goal: 50 km	Better than 10 km (w/GPS)	
Measurement Range 1. Wavelength 2. Brightness	Minimum: TBD TBD	Goal: 1-29 μm, 0.4-0.7 μm, 0.04-0.2 μm TBD	 1. 0.4 - 0.7 μm 0.04 - 0.2 μm 2. Shortwave brightness calibration from astronomical bodies	 1-29 μm subject to coolant lifetime and calibration uncertainties
Precision	Minimum: TBD	Goal:	Subject to calibration	User requirements on precision are usually not revealed
Measurement Uncertainty	Minimum: TBD	Goal: TBD	Consistent with uncertainties in emissivity of astronomical bodies	
Refresh	Minimum: TBD	Goal: Each orbit	Each orbit	Conditions change rapidly over durations shorter than 1 orbit

CONVERGENCE EFFORT MODIFICATION

40.14: AURORAL IMAGERY (Derived) page 1 of 2*			Lockheed PI: Dr. Yam Chiu	
Solution Type: ABIS, Low-Light Sensor, NADIS			Risk: Low to Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE EDR ATTRIBUTE VALUES	REMARKS
Coverage	Minimum: TBD	Goal: Global	Along const. swaths only	Global not pos. @ 800 km orbit
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	10 km along track only; ~ 30 km at edge of swath	
Mapping Accuracy	Minimum: TBD	Goal: 10 km	10 km (w/GPS) along track; TBD for edge of swath	
Measurement Range	Minimum:	Goal:		
1. wavelength	TBD	IR, visible, UV, and/or X-ray	UV, (IR, visible)	Long wave IR and X-ray req separate instruments
2. IR	TBD	TBD	Low-light sensor pass bands	7 year life achievable
3. visible	TBD	TBD	Low-light sensor pass bands	7 year life achievable
4. UV	TBD	0.5-15 kR @ 121.6 nm, 0.1-20 kR @ 130.4 nm, 0.05-4 kR @ 135.6 nm, 0.05-5 kR @ 140-180 nm	0.5-15 kR @ 121.6 nm, 0.1-20 kR @ 130.4 nm, 0.05-4 kR @ 135.6 nm, 0.05-5 kR @ 140-180 nm	FUV sensor life is much less than 7 years
5. X-ray	TBD	TBD	TBD	Not manifested in SESS due to limited utility. Can be added to SES if cost not a factor

* Obtaining auroral images in various wavelengths. Images change rapidly in space, time, and wavelength. Also key parameter in magnetosphere environment models

40.14: AURORAL IMAGERY (Derived) page 2 of 2			Lockheed PI: Dr. Yam Chiu	
Solution Type: ABIS, Low-light sensor, NADIS			Risk: Low to Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE EDR ATTRIBUTE VALUES	REMARKS
Precision	Minimum: TBD	Goal: TBD	TBD	Reference not clear*
Measurement Uncertainty	Minimum: TBD	Goal: 5%	TBD	Reference not clear*
Refresh	Minimum: each orbit	Goal: 30 min	Neither min nor goal achievable because aurora changes rapidly in space, time, and wavelength. Images from orbit to orbit have little correlation due to changes in time, orbit location, and auroral condition. Goal of 30 min not possible with 3 sats at 800 km. Auroras are keyed to magnetic fields and solar-interplanetary conditions, so concept of "refresh" has to be defined for such a case	

* It is not clear what and how to define "Precision" and "Measurement Uncertainty" for an image. Do we go to pixel level or EDR image recognition level?

CONVERGENCE EFFORT MODIFICATION

npoess

40.15: TOTAL AURORAL ENERGY DEPOSITION (Derived) Physical heat input parameter required for models of atmospheric densities.			Lockheed PI: Dr. Yam Chiu	
Solution Type: MEPS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE EDR ATTRIBUTE VALUES	REMARKS
Coverage	Minimum: Auroral Zone	Goal: Auroral Zone	Auroral zone; but on track only	Min and goal are in statistical sense
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	10 km along track 0 km cross track	A sort of cross track info can be obtained by correlation w/ auroral imagery data, but results are statistical and can hardly be quantitative
Mapping Accuracy	Minimum: TBD	Goal: 10 km	10 km (w/GPS)	
Measurement Range	Minimum: TBD	Goal: electrons: 10^{-5} - 1 W m^{-2} Ions: 10^{-5} - 10^{-1} W m^{-2}	Electrons: 10^{-5} - 1 W m^{-2} Ions: 10^{-5} - 10^{-1} W m^{-2}	
Precision 1. Flux 2. Mean Energy	Minimum: TBD TBD	Goal: 5% 20%	 1. 10% 2. 20%	1. Reqs complex cal for 5% flux accuracy which is energy dependent
Measurement Uncertainty	Minimum: TBD	Goal: 10%	10%**	

** Does not include sensitivity differences of sensors on different spacecraft. Historical records indicate inter - calibration differences of as much as a factor of 2 between NOAA-6 and TIROS-N.

40.16: UPPER ATMOSPHERE AIRGLOW (Derived) [p1 of 2] Measurements of airglow in the extreme and far ultraviolet portions of the spectrum can be used to infer the density of upper atmospheric neutral and ionized constituents.			Lockheed PI: Dr. Yam Chiu	
Solution Type: ABIS, NADIS			Risk: Low to Medium ABIS NADIS	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	**SPECIFICATIONS**		**BASELINE EDR ATTRIBUTE VALUES**	**REMARKS**
Coverage	Minimum: TBD	Goal: Global	Constellation swaths only	No global model to integrate data exists
Sensing Depth	Minimum: TBD	Goal: 80 - 750 km	100 - 750 km*	
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	10 km (w/GPS) along track; >200 km cross track	
Vertical Sampling Interval	Minimum: TBD	Goal: 5 km	10 km (NADIS)**	ABIS very coarse vertical
Mapping Accuracy	Minimum: TBD	Goal: 10 km	10 km along track; ~30 km @ edge of scan (ABIS); 200 km cross track (NADIS)	
Measurement Range	Minimum: TBD	Goal:		
1. Limb	TBD	10-1000 R @ 83.4 nm, 0.1-10 kR @ 135.6 nm 0.1-30 kR @ 140-180 nm	10-1000 R @ 83.4 nm 0.1-10 kR @ 135.6 nm, 0.1-30 kR @ 140-180 nm (NADIS)	
2. Disk	TBD	0.5-30 kR @ 121.6 nm 1-4000 R @ 135.6 nm, 1-5000 R @ 140-180 nm	0.5-30 kR @ 121.6 nm, 1-4000 R @ 135.6 nm, 1-5000 R @ 140-180 nm (ABIS)	

* Highly line specific and dependent on solar illumination; 80 km region cannot be resolved for the FUV lines as seen from 800 km; sensing depth here is meant in the integration sensing and does not involve vertical resolution of the EDR.

** Because of optical thickness problems with some of the lines, "Vertical Sampling Interval" does not imply vertical resolution of EDR.

3/15/95

npoess

40.16: UPPER ATMOSPHERE AIRGLOW (Derived) [p2 of 2] Measurements of airglow in the extreme and far ultraviolet portions of the spectrum can be used to infer the density of upper atmospheric neutral and ionized constituents.			Lockheed PI: Dr. Yam Chiu	
Solution Type: ABIS, NADIS			Risk: Low to Medium ABIS NADIS	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE EDR ATTRIBUTE VALUES	REMARKS
Precision	Minimum: none at this time	Goal: TBD	N/A	Modeling reqd to determine stat precision
Measurement Uncertainty	Minimum: none at this time	Goal: 5%	5% impossible to maintain over instrument life, which will be much less than 7 years	
Refresh	Minimum: each orbit	Goal: 30 min	each orbit	30 min not possible w/3 sat constellation

3/15/95

40.17: BATHYMETRY (Derived) page 1 of 2 (Deep Ocean and Near Shore).				Lockheed PI: Ken Hardy
Solution Type: OASIS, Altimeter			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE & LOW COST EDR ATTRIBUTE VALUES	HIGH COST 1: ALTIMETER
Sensing Depth	Minimum:	Goal:		
1. near shore	TBD	0 -200 m	0 - 5 m except 0 - 20 m in non-polluted water	N/A
2. deep ocean	TBD	0 - 300 m	N/A	0-4,000 m
Horizontal Spatial Resolution	Minimum:	Goal:		
1. near shore	TBD	TBD	0.65 to 1.3 km	N/A
2. deep ocean	TBD	300 m	N/A	15 km
Vertical Sampling Interval	Minimum: TBD	Goal: deep ocean & near shore, 1 m	5 m	± 100 m
Mapping Accuracy	Minimum: TBD	Goal: 10 m	4 km	10 m

npoess

40.17: BATHYMETRY (Derived) page 2 of 2 (Deep Ocean and Near Shore).				Lockheed PI: Ken Hardy
Solution Type: OASIS, Altimeter			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	**SPECIFICATIONS**		**BASELINE & LOW COST EDR ATTRIBUTE VALUES**	**HIGH COST 1: ALTIMETER**
Measurement Range	Minimum:	Goal:		
1. near shore	TBD	0 -200 m	0 - 20 m	N/A
2. deep ocean	TBD	0 -300 m	N/A	0 - 4,000 m
Measurement Uncertainty	Minimum: TBD	Goal: deep ocean & near shore, ±0.3 m	± 20 %	±10 %
Refresh	Minimum: TBD	Goal: TBD	Daily with near noon satellite	Deep ocean needs to be done once only

npoess

40.18: BIOLUMINESCENCE (Derived) A measurement of the number of bioluminescent organisms present in sea water within a region.			Lockheed PI: Dr. Keith Hutchison	
Solution Type: Low-Light Level Band of OASIS. EDR not included in any of the 4 Alternative Concepts.			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	**SPECIFICATIONS**		**Recommended EDR Attribute Values**	**REMARKS**
Horizontal Spatial Resolution	Minimum: TBD	Goal: TBD	1.3 km, Goal: 0.65 km	
Mapping Accuracy	Minimum: TBD	Goal: TBD	4 km	
Measurement Uncertainty	Minimum: TBD	Goal: TBD	Bioluminescence detected (Yes/No), Goal: 10 % of emitted radiance	
Refresh	Minimum: TBD	Goal: TBD	24 hours	Clear areas only
Measurement Range	Minimum: TBD	Goal: TBD	Minimum emission level that can be detected	Recommend "Measurement Range" be added as a requirement

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.19: CH_4 Column (Methane) (Derived)			Lockheed PI: Dr. Aidan Roche	
Solution Type: MOPITT(1998) or TES(2002) - to fly on EOS AM-1 and CHEM (MOPITT-Measurement of Pollutants in the Troposphere (Univ of Toronto, Can) TES- Tropospheric Emission Spectrometer (JPL))			Risk: Low to Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		HIGH COST 2: MOPITT	REMARKS
Sensing Depth	Minimum: TBD	Goal: TBD	Surface	
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10x10 km	20x20 km	Orbital track separation is ~1800 km for MOPITT
Vertical Sampling Interval (profile)	Minimum: TBD	Goal: TBD	3 weighting functions 0-15 km	TES lists 2-6 km from 0-33 km alt
Mapping Accuracy	Minimum: TBD	Goal: TBD	10%	TES: 8% of footprt MOPITT: 8%
Measurement Range (profile: 0-15 km)	Minimum: TBD	Goal: 40 - 80 μmoles/cm^2	1500-1600 ppbv 40-60 μmoles/cm^2	
Precision (column)	Minimum: TBD	Goal: 0.5%	1%	MOPITT~1% TES~1-2.5%
Measurement Uncertainty (column)	Minimum: TBD	Goal: ±5%	8%	
Refresh	Minimum: TBD	Goal: 24 hrs	36 hrs	Large cross-track swaths can cover selected areas more frequently (TES)

3/15/95

40.20: CLOUD COVER/LAYERS (Derived) Separate distinct cloud levels/coverage.			Lockheed PI: Dr. Keith Hutchison	
Solution Type: OASIS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	**SPECIFICATIONS**		**BASELINE & LOW COST ATTRIBUTE VALUES**	**REMARKS**
Horizontal Spatial Resolution	Minimum: TBD	Goal: TBD	1.3 km, Goal 0.65 km	
Vertical Sampling Interval	Minimum: TBD	Goal: 300 m increments	1.5 km	with MIS temp profile
Mapping Accuracy	Minimum: TBD	Goal: 1 km	4 km	
Measurement Uncertainty	Minimum: TBD	Goal: ±10%	±15 %	May meet goal with 1.38 micron band
Refresh	Minimum: TBD	Goal: 4 hrs	8 hrs from 2 satellites, 5.5 hrs from 3	Worst case for 100% coverage

3/15/95

npoess

40.21: CLOUD BASE HEIGHT (Derived)			Lockheed PI: Dr. Keith Hutchison	
Solution Type: Combined OASIS and MIS Moisture Sounder; Lidar for thin cirrus.			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE & LOW COST ATTRIBUTE VALUES	HIGH COST 2: LIDAR
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	50 km	10 km for thin clouds only at nadir
Vertical Sampling Interval	Minimum: TBD	Goal: Sfc to 30 km, 0.25 km	Sfc to 10 km, 2 km*	Sfc to 10 km, 1 km for thin clouds only at nadir*
Measurement Uncertainty	Minimum: TBD	Goal: 1 km	2 km*	1 km for thin clouds only at nadir*
Mapping Accuracy	Minimum: TBD	Goal: 1 km	4 km (3σ)	1 km
Refresh	Minimum: TBD	Goal: 4 hrs	11.1 hours for 3 satellites	12 hours nadir view only

*Values need to be confirmed.

3/15/95

40.22: CLOUD ICE, LIQUID EQUIVALENT (Derived) Mixing ratio of ice, expressed as a mixing ratio of the ice converted to liquid water by melting.			Lockheed PI: Dr. Keith Hutchison	
Solution Type: OASIS combined with Lidar. EDR not included in the Baseline Alternative Concept.			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		HIGH COST 2: LIDAR	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	10 km at nadir only	Scanning Lidar for global coverage
Vertical Sampling Interval	Minimum: TBD	Goal: 0.3 km	1 km at nadir only for cirrus	
Measurement Uncertainty	Minimum: TBD	Goal: 10^{-4} gm/gm	2×10^{-4} gm/gm	
Mapping Accuracy	Minimum: TBD	Goal: 1 km	1 km	
Refresh	Minimum: TBD	Goal: 4 hrs	12 hrs for 1 satellite	Nadir view only

CONVERGENCE EFFORT MODIFICATION

npoess

40.23: CLOUD LIQUID WATER (Derived) Measurement of water equivalent within clouds.			Lockheed PI: Dr. Keith Hutchison	
Solution Type: MIS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE & LOW COST ATTRIBUTE VALUES	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 5 km	50 km	Over ocean surfaces only
Vertical Sampling Interval	Minimum: TBD	Goal: 0.3 km	Total column	Lidar needed for vert intvl
Measurement Uncertainty	Minimum: TBD	Goal: ±0.01 mm	±0.06 mm	Based on MIS simulations
Mapping Accuracy	Minimum: TBD	Goal: 1 km	7 km	
Refresh	Minimum: TBD	Goal: 4 hrs	5.5 hrs from 3 satellites	Worst case

Note: Cloud Liquid Water is also called out as part of 40.62: Total Water Content. Both 40.23 and 40.62 include a "Vertical Sampling Interval". Since the "Baseline Attribute Value" for the Vertical Sampling Interval is for the total column in both 40.23 and 40.62, there is no difference between 40.23 and that given in 40.62.

3/15/95

40.24: CLOUD ICE WATER PATH (Derived) [page 1 of 2] A measure of the equivalent water mass of the ice particles in unit vertical column through the cloud. Measured information must be sensitive to the number of particles, their sizes, and their densities.				Lockheed PI: Dr. Keith Hutchison
Solution Type: OASIS combined with Lidar. EDR not included in the Baseline Alternative Concept.			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		HIGH COST 2: LIDAR	REMARKS
Sensing Depth	Minimum: TBD	Goal: TBD	Sfc to 20 km for ice clouds	Nadir view only
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	10 km at nadir only	
Vertical Sampling Interval	Minimum: TBD	Goal: TBD	1 km	Nadir view only
Mapping Accuracy	Minimum: TBD	Goal: TBD	1 km	

npoess

40.24: CLOUD ICE WATER PATH (Derived) [page 2 of 2] A measure of the equivalent water mass of the ice particles in unit vertical column through the cloud. Measured information must be sensitive to the number of particles, their sizes, and their densities.			Lockheed PI: Dr. Keith Hutchison	
Solution Type: OASIS combined with Lidar. EDR not included in the Baseline Alternative Concept.			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	**SPECIFICATIONS**		**HIGH COST 2: LIDAR**	**REMARKS**
Measurement Range	Minimum: TBD	Goal: 0-1 mm	0-1 mm	Effective cloud optical depth may be retrieved with IR profiler when only ice clouds are present
Precision	Minimum: TBD	Goal: TBD	0.05 mm	
Measurement Uncertainty	Minimum: TBD	Goal: ±0.01 mm	±0.1 mm	Nadir view only for thin cirrus
Refresh	Minimum: TBD	Goal: 4 hrs	12 hours for one satellite	Nadir view only

3/15/95

40.25: CLOUD OPTICAL DEPTH/TRANSMITTANCE (Derived) Measurement of cloud optical thickness and emissivity in the visible and IR portions of the spectrum.			Lockheed PI: Dr. Keith Hutchison	
Solution Type: IR Profiler			Risk: Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE & LOW COST ATTRIBUTE VALUES	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	15 km at nadir	IR profiler may meet goal at nadir
Measurement Uncertainty	Minimum: TBD	Goal: ±5%	Emissivity 0.1 at infrared wavelengths	Applies only to single layers of thin cirrus clouds
Mapping Accuracy	Minimum: TBD	Goal: 10 km	7 km	
Refresh	Minimum: TBD	Goal: 3 hrs	11.1 hrs from 3 satellites	Worst case for 81% coverage

npoess

40.26: CLOUD TOP PRESSURE (Derived) Derivied pressure at cloud tops.			Lockheed PI: Dr. Keith Hutchison	
Solution Type: OASIS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE & LOW COST ATTRIBUTE VALUES	REMARKS (IR PROFILER)
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	1.3 km	15 km
Measurement Uncertainty	Minimum: TBD	Goal: 30 mb	50 mb (water clouds)	50-100 mb (ice clouds)
Mapping Accuracy	Minimum: TBD	Goal: 10 km	4 km	7 km
Refresh	Minimum: TBD	Goal: 6 hrs	5.5 hrs for 3 satellites (worst case)	11.1 hrs for 3 satellites (worst case)

npoess

40.27: CLOUD TOP TEMPERATURE (Derived)			Lockheed PI: Dr. Keith Hutchison	
Solution Type: OASIS, IR profiler			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE & LOW COST ATTRIBUTE VALUES	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	1.3 km 15 km	OASIS IR Profiler
Measurement Uncertainty	Minimum: TBD	Goal: TBD	3 K (for water clouds) 5-10 K (ice clouds)	OASIS IR Profiler
Mapping Accuracy	Minimum: TBD	Goal: 1 km	4 km 7 km	OASIS IR Profiler
Refresh	Minimum: TBD	Goal: 6 hrs	11.1 hrs for 3 satellites	Worst case for 81% coverage

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.28: CLOUD TOP HEIGHT (Derived)			Lockheed PI: Dr. Keith Hutchison	
Solution Type: OASIS/MIS, IR Profiler			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE & LOW COST ATTRIBUTE VALUES	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	1.3 km 15 km	OASIS IR Profiler
Vertical Sampling Interval	Minimum: TBD	Goal: 0.25 km	TBR	TBR
Measurement Uncertainty	Minimum: TBD	Goal: 0.25 km	0.5 km for water clouds 2-3 km for ice clouds	OASIS IR Profiler
Mapping Accuracy	Minimum: TBD	Goal: 10 km	4 km	7 km
Refresh	Minimum: TBD	Goal: 6 hrs	11.1 hrs for 3 satellites	Worst case for 81% coverage

3/15/95

npoess

40.29: CO COLUMN (CARBON MONOXIDE) (Derived)		Lockheed PI: Dr. Aidan Roche	
Solution Type:MOPITT(1998) or TES(2002) - to fly on EOS AM-1 and CHEM (MOPITT-Measurement of Pollutants in the Troposphere (Univ of Toronto, Can) TES- Tropospheric Emission Spectrometer (JPL))		Risk: Low to medium	

DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		HIGH COST 2: MOPITT	REMARKS
Sensing Depth	Minimum: TBD	Goal TBD	Surface	
Horizontal Spatial Resolution	Minimum: TBD	Goal: 100 km	20x20 km	Orbital track separation is ~1800 km for MOPITT, Swath ~ 600 km
Vertical Sampling Interval (profile)	Minimum: TBD	Goal: TBD	3 weighting functions 0-15 km	MOPITT~5 km TES~2-3 km
Mapping Accuracy	Minimum: TBD	Goal: TBD	10 km	MOPITT:8% of IFOV TES: 8% of IFOV
Measurement Range (profile 0-15 km)	Minimum: TBD	Goal: 0 - 7 μmoles/cm^2	37-100 ppbv 0.4-6μmoles/cm^2	
Precision (column)	Minimum: TBD	Goal: 1%	5%	TES~10% for profile
Measurement Uncertainty (column)	Minimum: TBD	Goal: ±3%	6%	MOPITT~10% for profile
Refresh	Minimum: TBD	Goal: 24 hrs	36 hrs	EOS-type sun-synchron orbit

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.30: CO_2 COLUMN (CARBON DIOXIDE) (Derived)			Lockheed PI: Dr. Aidan Roche	
Solution Type:IMG (Interferometric Measurement of Greenhouse Gases (IR), TERSE (Tuneable Etalon Radiometer for Earth Sensing (IR,Vis), SCIAMACHY (Scanning Imaging Absorption Spectrometer for Atmospheric Cartography (UV-Vis-NearIR). EDR not included in the 4 alternative concepts.			Risk: IMG: Low-Med TERSE: High SCIAM: Low-Med	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Recommended EDR Attribute Values	REMARKS
Sensing Depth	Minimum: TBD	Goal TBD	Surface	
Horizontal Spatial Resolution	Minimum: TBD	Goal: 100 km	20x20 km	
Vertical Sampling Interval (profile)	Minimum: TBD	Goal: TBD	5 km	
Mapping Accuracy	Minimum: TBD	Goal: TBD	10%	
Measurement Range (profile: 0-15 km)	Minimum: TBD	Goal: 11,000 - 15,000 μmoles/cm^2	11,000 - 15,000 μmoles/cm^2	
Precision (column)	Minimum: TBD	Goal: 0.1%	1 %	
Measurement Uncertainty	Minimum: TBD	Goal: ±1%	±1%	
Refresh	Minimum: TBD	Goal: 24 hrs	36 hours	

3/15/95

40.31: CURRENTS [Derived] Large scale movements of the surface waters of the ocean driven by wind, and the distribution of water density. Currents are a vector quantity with both speed and direction.				Lockheed PI: Dr. Keith Hutchison
Solution Type: SeaWiFS?			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		HIGH COST 2: SeaWiFS	REMARKS
Sensing Depth	Minimum: TBD	Goal: 0 - 30 m	Surface	
Horizontal Spatial Resolution	Minimum: 20 km Global, 10 km Regional	Goal: TBD Global, 5 km Regional	15 km	
Vertical Sampling Interval	Minimum: TBD	Goal: 1 m	N/A	
Mapping Accuracy	Minimum: TBD	Goal: 5 km	4 km	
Measurement Range	Minimum: TBD	Goal: 0 -500 cm/s	0-500 cm/s	Needs confirmation
Precision	Minimum: TBD	Goal: 0.1 cm/sec	1 cm/s	Needs confirmation
Measurement Uncertainty	Minimum: TBD	Goal: ±10%	±20%	Needs confirmation
Refresh	Minimum: 24 hrs	Goal: 12 hrs	24 hrs for clear areas on two successive satellite passes	Derived from daily changes in ocean features

3/15/95

40.32: ELECTRIC FIELDS (Derived) Electric field data in the auroral and polar cap regions are needed as real-time input to operational space environmental models of the magnetosphere and ionosphere.*				Lockheed PI: Dr. Yam Chiu
Solution Type: RPAD			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE EDR ATTRIBUTE VALUE	REMARKS
Coverage	Minimum: Polar/Auroral	Goal: Global	Global; along track only for instrument data	Modeling reqd for true global coverage
Horizontal Spatial Resolution	Minimum: 10 km	Goal: 3 km	Along track only	No cross-track spatial resolution
Mapping Accuracy	Minimum: TBD	Goal: 10 km	10 km with GPS	
Measurement Range	Minimum: TBD	Goal: ±500 mV/m	±500 mV/m	
Precision	Minimum: TBD	Goal: ±1 mV/m	±500 mV/m	
Measurement Uncertainty	Minimum: TBD	Goal: ±2 mV/m	±2 mV/m	
Refresh	Minimum: 2/orbit	Goal: 15 min	2/orbit	goal not possible with 3 satellites

* EDR must be cast in the form of model for global or polar/auroral coverage

3/15/95

npoess

40.33: ELECTRON DENSITY PROFILES/IONOSPHERIC SPECIFICATION (Derived): Ionosphere affects electromagnetic wave propagation over the range from radio to microwave frequencies. page 1 of 2

Lockheed PI: Dr. Yam Chiu

Solution Type: GPSR, RPAD, ABIS, NADIS

RISK: Low; NADIS Medium

DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline EDR Attribute Values	REMARKS
Coverage	Minimum: TBD	Goal: Global	Global	May be integ w/ other operational models and ground data
Sensing Depth	Minimum: TBD	Goal: 90-36,000 km	170-20,000 km	Satellite-borne sensor cannot reach 90-170 km for longer than a couple of perigee passes
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	RPAD: 3 km along track GPSR: Tomog: 300 km globally ABIS: 10 km on swath NADIS: 10 km along track, 300 km swath cross track	
Vertical Sampling Interval	Minimum: TBD	Goal: 5 km	GPSR: 2 km RPAD: No in-situ ABIS: >20 km NADIS: 5 km	
Mapping Accuracy	Minimum: TBD	Goal: 10 km	10 km (GPS)	

3/15/95

40.33: ELECTRON DENSITY PROFILES/IONOSPHERIC SPECIFICATION (Derived): Ionosphere affects on electromagnetic wave propagation over the range from radio to microwave frequencies. page 2 of 2				Lockheed PI: Dr. Yam Chiu
Solution Type: GPSR, RPAD, ABIS, NADIS			RISK Low; NADIS Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		BASELINE & LOW COST EDR ATTRIBUTE VALUES	REMARKS
Measurement Range	Minimum: TBD	Goal: local density: 10^4-10^7 cm^{-3}; TEC: 10^{15} - $2x10^{18}$ m^{-2}; f_0F2: 1 -30 Mhz	RPAD:local density: 10^4-10^7 GPSR, NADIS: TEC lower limit $10^{16}m^{-2}$, f_0F2: 1 -30 Mhz	May be used in conjunc. with other operational models and ground data
Precision	Minimum: TBD	Goal: 10^4 cm^{-3}; TEC: $0.5x10^{16}$ m^{-2}	10^4 cm^{-3}; TEC: $0.5x10^{16}$ m^{-2}	
Measurement Uncertainty	Minimum: TBD	Goal: local density: $\pm10^4$ cm^{-3}; NmF2: 5%; HmF2: 5 km; TEC: $\pm10^{16}$ m^{-2};	local density: $\pm10^4$ cm^{-3} HmF2: 10 km; TEC: $\pm10^{16}$ m^{-2}	F2 peak is usually broad so HmF2 to 5 km is overkill
Refresh	Minimum: each orbit	Goal: 30 min	each orbit	30 min not possible with 3 sats

40.34: ENERGETIC CHARGED PARTICLES 40.34.1: SUPRA-THERMAL/AURORAL PARTICLES [Derived]				Lockheed PI: Dr. Yam Chiu
Solution Type: MEPS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline EDR Attribute Values	REMARKS
Coverage	Minimum: Global	Goal: Global	Global in sense of along trk only	Fluxes of these particles change rapidly; only statistical models exist
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	10 km along track only; no cross track resolution	
Mapping Accuracy	Minimum: TBD	Goal: 10 km	10 km (w/GPS)	
Measurement Range 1. Energy 2. Flux	Minimum: TBD TBD	Goal: 1. 30 eV to 30 keV 2. 10^8-10^{15} m^{-2} sec^{-1} $ster^{-1}$ keV^{-1}	1. 30 eV to 30 keV 2. 10^8-10^{15} m^{-2} sec^{-1} $ster^{-1}$ keV^{-1}	
Precision 1. Energy 2. Flux	Minimum: TBD TBD	Goal: 1. $\Delta E/E = 0.1$ 2. 5%	1. $\Delta E/E = 0.1$ 2. 10%	2. Flux spectrum calibration energy dependent; 5% difficult to maintain
Measurement Uncertainty	Minimum: TBD	Goal: 10%	10%	
Refresh	Minimum: TBD	Goal: TBD	N/A	Due to rapid fluct refresh not meaningful

npoess

40.34: ENERGETIC CHARGED PARTICLES 40.34.2: RADIATION BELT/LOW ENERGY SOLAR PARTICLES [Derived] page 1 of 2			Lockheed PI: Dr. Yam Chiu	
Solution Type: HEPS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	**SPECIFICATIONS**		**Baseline EDR Attribute Values**	**REMARKS**
Coverage	Minimum: Global	Goal: Global	Global in sense of along track only	Some mapping along field lines for global cover possible; require model to provide global coverage
Horizontal Spatial Resolution	Minimum: TBD	Goal: 30 km	30 km along trk only; no ctrk res	
Mapping Accuracy	Minimum: TBD	Goal: 30 km	30 km (w/GPS)	
Measurement Range	Minimum:	Goal:		
1. Energy	TBD	ions: 30 keV to 10 MeV in 8 bands, electrons: 30 keV to 10 MeV in 8 bands	ions: 30 keV to 10 MeV in 8 bands, electrons: 30 keV to 10 MeV in 8 bands	
2. Flux	TBD	ions: 10^6-10^{12} m^{-2} sec^{-1} $ster^{-1}$ keV^{-1}, electrons: 10^6-10^{12} m^{-2} sec^{-1} $ster^{-1}$	ions: 10^6-10^{12} m^{-2} sec^{-1} $ster^{-1}$ keV^{-1}, electrons: 10^6-10^{12} m^{-2} sec^{-1} $ster^{-1}$	

3/15/95

40.34: ENERGETIC CHARGED PARTICLES 40.34.2: RADIATION BELT/LOW ENERGY SOLAR PARTICLES [Derived] page 2 of 2				Lockheed PI: Dr. Yam Chiu
Solution Type: HEPS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline EDR Attribute Values	REMARKS
Precision	Minimum:TBD	Goal: 5%	10% optimal	Flux precision strongly dependent on flux level. 10% cannot be guaranteed over the entire dynamic range
Measurement Uncertainty	Minimum: TBD	Goal: 10%	10% optimal	Flux precision strongly dependent on flux level. 10% cannot be guaranteed over the entire dynamic range
Refresh	Minimum: TBD	Goal: TBD	N/A	

3/15/95

npoess

40.34: ENERGETIC CHARGED PARTICLES 40.34.3: SOLAR/GALACTIC COSMIC RAY PARTICLES [Derived] p 1 of 2				Lockheed PI: Dr. Yam Chiu
Solution Type: HEPS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline EDR Attribute Values	REMARKS
Coverage	Minimum: Global	Goal: Global	Global in sense of along trk only	Reqd model for global coverage
Horizontal Spatial Resolution	Minimum: TBD	Goal: 50 km	50 km along trk only; no ctrk resolution	Model res much less than 200 km
Mapping Accuracy	Minimum: TBD	Goal: 50 km	50 km along trk only (w/GPS)	
Measurement Range 1. Energy	Minimum: TBD	Goal: protons: 10 MeV to 1000 MeV in 8 bands, alphas: 10 MeV to 1000 MeV in 8 bands heavy ions: (CNO): 10-100 MeV in 4 bands heavy ions (Fe): 10-100 MeV in 4 bands	protons: 10 MeV to 1000 MeV in 8 bands, alphas: 10 MeV to 1000 MeV in 8 bands heavy ions: (CNO): 10-100 MeV in 4 bands heavy ions (Fe): 10-100 MeV in 4 bands	

3/15/95

npoess

40.34: ENERGETIC CHARGED PARTICLES 40.34.3: SOLAR/GALACTIC COSMIC RAY PARTICLES [Derived] p 2 of 2				Lockheed PI: Dr. Yam Chiu
Solution Type: HEPS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline EDR Attribute Values	REMARKS
Measurement Range 2. Flux	Minimum: TBD	Goal: protons: 10^2-10^{10} m^{-2} sec^{-1} $ster^{-1}$, alphas: 10^2-10^8 m^{-2} sec^{-1} $ster^{-1}$, heavy ions: (CNO): 10^{-5} - 1.0 m^{-2} sec^{-1} $ster^{-1}$, heavy ions (Fe): 10^{-5} - 1.0 m^{-2} sec^{-1} $ster^{-1}$	protons: 10^2-10^{10} m^{-2} sec^{-1} $ster^{-1}$, alphas: 10^2-10^8 m^{-2} sec^{-1} $ster^{-1}$, heavy ions: (CNO): 10^{-5} - 1.0 m^{-2} sec^{-1} $ster^{-1}$, heavy ions (Fe): 10^{-5} - 1.0 m^{-2} sec^{-1} $ster^{-1}$	
Precision	Minimum:TBD	Goal: 5%	10% optimal	Flux precision strongly dependent on flux level. 10% cannot be guaranteed over the entire dynamic range
Measurement Uncertainty	Minimum: TBD	Goal: 10%	10% optimal	Flux precision strongly dependent on flux level. 10% cannot be guaranteed over the entire dynamic range
Refresh	Minimum: TBD	Goal: TBD	N/A	

3/15/95

40.35: FRESH WATER ICE CONCENTRATIONS (page 1 of 2; Derived)		RISK: Low for OASIS & MIS High for SAR		Lockheed PI: Mike Davis	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		LOW COST & BASELINE EDR VALUES		HIGH COST 1
	MINIMUM	GOAL	OASIS(a)	MIS(b)	SAR
Sensing Depth	ice surface	1 m	Ice surface	Ice surface	Sfc to 1 m
Horizontal Spatial Resolution					
1. ice edge boundary	600 m	100 m	650 m nadir to 1300 m	12.5 to 50 km	600 m
2. ice concentration	600 m	100 m	650 - 1300 m	12.5 - 50 km	600 m
Vertical Sampling Interval 1. ice thickness	TBD	20 cm	N/A	≤0.01 m or >0.01 m	0.5 m
Mapping Accuracy	3 km	1 km	4 km	7 km	60 m
Measurement Range					
1. ice edge boundary	TBD	TBD	650 to 1300 m	12.5 to 50 km	600 m
2. ice concentration	1/10 to 10/10 cover	0/10 to 10/10 cover	0/10 or 10/10	0/10 to 10/10 cover	0/10 to 10/10 cover
3. ice thickness	TBD	0 to 1.5 m	N/A	≤0.01 m or >0.01 m (new ice only)	0-1 m

(a) Clear skies only (b) See issues for Sea Ice

3/15/95

40.35: FRESH WATER ICE CONCENTRATIONS (page 2 of 2; Derived)	RISK: Low for OASIS & MIS High for SAR	Lockheed PI: Mike Davis

DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		LOW COST & BASELINE		HIGH COST 1
	MINIMUM	GOAL	OASIS	MIS	SAR
Measurement Uncertainty					
1. ice edge boundary	±10%	±5%	4 km (worst mapping accuracy)	12.5 to 50 km	±10% or 60 m (mapping accuracy)
2. ice concentration	±20%	±10%	±20%	±20%	±10%
3. ice thickness	TBD	±10%	N/A	new ice: <0.01 or >0.01 m	±50%
Refresh	12 hrs	6 hours	24 hours (clear areas)	24 hours	24-48 hrs

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.36: GEOMAGNETIC FIELD (Derived) Measurements of the Earth's vector magnetic field.				Lockheed PI: Dr. Yam Chiu
Solution Type: VECMAG			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline EDR Attribute Values	REMARKS
Coverage	Minimum: TBD	Goal: Global	Int Field: Global Ex Field: Local	Ex Field Uncertain due to space-time flucts
Horizontal Spatial Resolution	Minimum: TBD	Goal: 500 m	Int Field: 500m Ex Field: >1000 km	Ex Field goal not possible
Mapping Accuracy	Minimum: TBD	Goal: 100 m SEP	100 m (w/GPS)	
Measurement Range	Minimum: TBD	Goal: 20,000-50,000 nT	20,000-50,000 nT	
Precision	Minimum: TBD	Goal: 0.5 nT	1 nT	
Measurement Uncertainty	Minimum: TBD	Goal: 2 nT	2 nT	
Sensor Attitude	Minimum: TBD	Goal: 1 arc min	1 arc min	Strongly dependent on boom design
Timing Accuracy	Minimum: TBD	Goal: 0.5 msec	0.5 msec	
Refresh	Minimum: TBD	Goal: TBD	Internal field: 1/orbit; External field: N/A	

npoess

40.37: ICE SURFACE TEMPERATURE (Derived) Ambient temperature at the ice/air interface.				Lockheed PI: Dr. Keith Hutchison
Solution Type: OASIS/MIS			Risk: Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline and Low Cost EDR Attribute Values	REMARKS
Horizontal Spatial Resolution	Minimum: 30 km	Goal: 10 km	10 km 50 km	OASIS MIS
Measurement Range	Minimum: -60 to +20° C	Goal: TBD	-60 to +20° C No MIS capability	OASIS
Measurement Uncertainty	Minimum: ±2° C	Goal: ±1° C	±2° C for OASIS	Cloud-free areas only
Mapping Accuracy	Minimum: 3 km	Goal: 1 km	4 km	OASIS
Refresh	Minimum: 48 hrs	Goal: 12 hrs	~24 hrs	Depends on cloud-free areas

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.38: IN-SITU MEASUREMENTS 40.38.1: IN-SITU PLASMA DENSITY [Derived] Ion composition information is required to determine the altitude of transition between oxygen and lighter ion species, which is an input to high altitude ionospheric models *.	Lockheed PI: Dr. Yam Chiu
Solution Type: RPAD (with mass descimination added?)	Risk: Low

DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline EDR Attribute Values	REMARKS
Coverage	Minimum: TBD	Goal: Global	Along track only	Global in modeling sense; see 40.33: Electron Density
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	10 km along track with no mass discrimination only	Mass discrim reqs longer integ & cycling times
Mapping Accuracy	Minimum: TBD	Goal: 10 km	10 km (w/GPS)	
Measurement Range	Minimum: TBD	Goal: 10^2-10^7 cm^{-3}	10^2-10^4 cm^{-3} (what mass?)	Large dynamic range requires longer cycle time. At 800 km, 10^7 cm^{-3} is overkill by 10^3.
Precision	Minimum: TBD	Goal: 2%	10% (what mass?)	2% not possible due to rapid fluctuations
Measurement Uncertainty	Minimum: TBD	Goal: 5%	10% (what mass?)	2% not possible due to rapid fluctuations
Refresh	Minimum: each orbit	Goal: each orbit	Each orbit	

* In-situ means at the satellite altitude. A single altitude (800 km) measusrement cannot determine the transition altitude between oxygen and lighter ions, even if mass descrimination is added to RPAD. Also, specs do not specify mass descrimination. There seems to be an inconsistency in requirements.

3/15/95

npoess

40.38: IN-SITU MEASUREMENTS 40.38.2: IN-SITU PLASMA TEMPERATURE [Derived] Plasma temperatures are used in the mid-latitude region.				Lockheed PI: Dr. Yam Chiu
Solution Type: RPAD			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline EDR Attribute Values	REMARKS
Coverage	Minimum: TBD	Goal: Global	Along const tracks only	No global model exists in this EDR
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	10 km along trk only; no ctrk res	
Mapping Accuracy	Minimum: TBD	Goal: 10 km	10 km (w/GPS)	
Measurement Range	Minimum: TBD	Goal: 500-10,000 K	500 - 10,000 K	
Precision	Minimum: TBD	Goal: 50 K	50K@ optimal conditions	Lrge fluctuations degrade precision
Measurement Uncertainty	Minimum: TBD	Goal: 5%	5%@ optimal conditions	Lrge fluctuations degrade measurements
Refresh	Minimum: each orbit	Goal: each orbit	Each orbit	

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.38: IN-SITU MEASUREMENTS **40.38.3: ION DRIFT VELOCITY** [Derived] Measurements of in-situ plasma drift velocities are used to infer electric field strengths and patterns in the auroral polar cap regions.				Lockheed PI: Dr. Yam Chiu
Solution Type: RPAD			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	**SPECIFICATIONS**		**Baseline EDR Attribute Values**	**REMARKS**
Coverage	Minimum: Polar/Auroral	Goal: Global	Along const tracks only	Global coverage in the sense of model only
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	Along track only	Model resolution is very coarse >300 km
Mapping Accuracy	Minimum: TBD	Goal: 10 km	10 km (w/GPS)	
Measurement Range	Minimum: TBD	Goal: ±10 km/sec	±10 km/sec	
Precision	Minimum: TBD	Goal: 25 m/sec	25 m/sec; limited by integ time	Fast fluctuations degrade precision
Measurement Uncertainty	Minimum: TBD	Goal: 50 m/sec	50 m/sec@ optimal conds	Fast fluctuations degrade measurements
Refresh	Minimum: 2/orbit	Goal: 15 min	2/orbit	15min impossible for global; rapid auroral changes reqs definition of'refresh'

3/15/95

npoess

40.39: IONOSPHERIC MEASUREMENTS
40.39.1: IONOSPHERIC SCINTILLATION [Derived] page 1 of 2

Measured Quantity: C_kL, the height-integrated strength of the ionospheric irregularity spectrum at a one km scale size; q, the slope of the in-situ irregularity spectrum; and V_d, the ion drift velocity. The following requirements are for C_kL. The measurement range, precision, and accuracy for q and V_d should be consistent with meeting the C_kL requirements. Note that V_d is the same drift velocity used for electric field determination required elsewhere in the system specification and might need to meet a more stringent requirement for that purpose.*

Lockheed PI: Dr. Yam Chiu

Solution Type: Radio Beacon Receiver. EDR is not included in any of the 4 alternative Concepts

Risk: Low

DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Recommended EDR Attribute Values	REMARKS
Coverage	Minimum: Global	Goal: Global	At globally distributed ground beacon sites only	global coverage in the sense of model update only
Sensing Depth	Minimum: TBD	Goal: 200-800 km	200-800 km @ gnd beacon sites	
Horizontal Spatial Resolution	Minimum: TBD	Goal: TBD	N/A; measurements are at ground beacon sites	Model resolution not known
Mapping Accuracy	Minimum: TBD	Goal: 10 km	10 km (w/GPS)	

*Note: Scintillation measurements of CkL and q require a bistatic observational set-up. The WIDEBAND satellite, from which WBMOD is derived, has demonstrated the measurements with a multiple frequency transmitter on board and a single receiver station at Poker Flats, Alaska. For NPOESS, WBMOD needs measurements from a global set of receiver stations (auroral, mid-latitude and equatorial) in order to provide continuous verification and refresh of WBMOD predictions. Similar to WIDEBAND, a 10-frequency transmitter is placed on board NPOESS satellites. The instruments are proven and the methods of analyses are known.

3/15/95

40.39: IONOSPHERIC MEASUREMENTS **40.39.1: IONOSPHERIC SCINTILLATION** [Derived] page 2 of 2 Measured Quantity: C_kL, the height-integrated strength of the ionospheric irregularity spectrum at a one km scale size; q, the slope of the in-situ irregularity spectrum; and V_d, the ion drift velocity. The following requirements are for C_kL. The measurement range, precision, and accuracy for q and V_d should be consistent with meeting the C_kL requirements. Note that V_d is the same drift velocity used for electric field determination required elsewhere in the system specification and might need to meet a more stringent requirement for that purpose.	Lockheed PI: Dr. Yam Chiu
Solution Type: Radio Beacon Receiver. EDR is not included in any of the 4 alternative Concepts	Risk: Low

DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Recommended EDR Attribute Values	REMARKS
Measurement Range	Minimum: TBD	Goal: C_kL: 10^{27}-10^{37}	10^{28}-10^{37}	@ optimal, no saturation conditions; 10^{27} is probably overkill because such small values of C_kL (i.e. PDS) also implies large measurement errors
Precision	Minimum: TBD	Goal: 10^{27}	10^{28}	@ optimal: see above
Measurement Uncertainty	Minimum: TBD	Goal: factor of 2	factor of 2	
Refresh	Minimum: each orbit	Goal: each orbit	Each orbit in model update sense	

40.39: IONOSPHERIC MEASUREMENTS **40.39.2: IN-SITU PLASMA FLUCTUATIONS** [Derived] The ionsopheric structures responsible for scintillation occur primarily at altitudes near the peak of the F_2 region (250 - 400 km)*.	Lockheed PI: Dr. Yam Chiu
Solution Type: RPAD	Risk: Low

DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline EDR Attribute Values	REMARKS
Coverage	Minimum: Global	Goal: Global	Along track only	No global model exists
Horizontal Spatial Resolution	Minimum: TBD	Goal: TBD	Along track only	
Mapping Accuracy	Minimum: TBD	Goal: 10 km	10 km (w/GPS)	
Measurement Range	Minimum: TBD	Goal: $\Delta N/N$: 10^{-4}-1.0	10^{-2} - 1.0	10^{-4} @ 800 km where N~10^3-10^4 cm^{-3} not possible
Precision	Minimum: TBD	Goal: 10%	10% @ optimal conditions	Measurement degrades when denisty is in the low range
Measurement Uncertainty	Minimum: TBD	Goal: ±10%	±10%@ optimal conditions	Measurement degrades when denisty is in the low range
Refresh	Minimum: each orbit	Goal: each orbit	Each orbit in the sense of revisit along track	No plasma fluct model exists

* In-situ measurement means at the satellite. NPOESS @ 800 km cannot make in-situ plasma fluctuation measurement for (250-400 km) F2 region peak. There seems to be an inconsistency in the requirements. All responses to this EDR are for in-situ measurements at 800 km. There is no currently known way to measure plasma fluctuations at the F-peak from 800 km.

3/15/95

npoess

40.40: LAND SURFACE TEMPERATURE [Derived] Measurement of the temperature of the soil at the surface.				Lockheed PI: Dr. Keith Hutchison
Solution Type: OASIS/MIS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline & Low Cost EDR Attribute Values	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 1 km	1.3 km 12.5 to 50 km	OASIS MIS
Mapping Accuracy	Minimum: TBD	Goal: 1 km	4 km	OASIS
Precision	Minimum: TBD	Goal: 0.25 K	0.25 K	
Measurement Uncertainty	Minimum: TBD	Goal: ±1 K	±3 K	OASIS TBR for MIS
Refresh	Minimum: TBD	Goal: 3 hrs	5.5 hrs for 3 satellites (worst case for 100% coverage)	Clear areas only for OASIS

3/15/95

npoess

40.41: LITTORAL SEDIMENT TRANSPORT [Derived] The transport of sediment by river systems and along shore currents.				Lockheed PI: Dr. Keith Hutchison
Solution Type: Like SeaWIFS. EDR is not provided in any of the 4 alternative concepts			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 2: SeaWiFS	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	1.3 km	
Mapping Accuracy	Minimum: TBD	Goal: TBD	4 km	
Measurement Range	Minimum: TBD	Goal: 100 m	0-5000 cu m/day (needs confirmation)	Is this the right unit?
Measurement Uncertainty	Minimum: TBD	Goal: cu m/day	2000 cu m/day (needs confirmation)	Need numerical value for goal?
Refresh	Minimum: TBD	Goal: TBD	24 hrs	Cloud-free areas

npoess

40.42: LONGWAVE RADIATION [Derived] Downward longwave radiation (DLR)			Lockheed PI: Dr. Ken Hardy	
Solution Type: CERES			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 2: CERES	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	40 km at nadir	
Mapping Accuracy	Minimum: TBD	Goal: TBD	10 km	Needs confirmation
Measurement Range	Minimum: TBD	Goal: 0 -500 W/m^2	0 -500 W/m^2	
Precision	Minimum: TBD	Goal: 0.1 W/m^2	0.1 W/m^2	
Measurement Uncertainty	Minimum: TBD	Goal: ± 1 W m^{-2}	± 5 W/m^2	
Refresh	Minimum: TBD	Goal: 6 hrs	14 hrs	Worst case for 1 satellite

3/15/95

40.43: NET HEAT FLUX [Derived]			Lockheed PI: Dr. Ken Hardy	
Solution Type: Profiler Suite, OASIS, MIS			Risk: Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline & Low Cost EDR Attribute Values	REMARKS
Sensing Depth	Minimum: TBD	Goal: TBD	air/sea interface	
Horizontal Spatial Resolution	Minimum: TBD	Goal: 5 km	50 km	
Vertical Sampling Interval	Minimum: TBD	Goal: TBD	Ocean sfc only	Low level resolution of profilers
Mapping Accuracy	Minimum: TBD	Goal: TBD	7 km	
Measurement Range	Minimum: TBD	Goal: 0 - 1000 W/m^2	-500 to 1000 W/m^2	
Precision	Minimum: TBD	Goal: ± 1 W/m^2	± 1 W/m^2	
Measurement Uncertainty	Minimum: TBD	Goal: ± 1 W/m^2	± 50 W/m^2	Needs confirmation
Refresh	Minimum: TBD	Goal: 3 hrs	14 hours for clear areas	Worst case

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.44: NET RADIATION (TOP OF ATMOSPHERE) [Derived] Difference between the net solar radiation and outgoing longwave radiation, 24 hour average.				Lockheed PI: Dr. Ken Hardy
Solution Type: CERES			Risk: Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 2: CERES	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	40 km	CERES FOV at nadir
Mapping Accuracy	Minimum: TBD	Goal: TBD	10 km	Needs confirmation
Measurement Range	Minimum: TBD	Goal: 0 -1,400 W/m^2	0 -1,400 W/m^2	Relates to incoming solar and not the net
Precision	Minimum: TBD	Goal: 0.1 W/m^2	0.1 W/m^2	
Measurement Uncertainty	Minimum: TBD	Goal: ±1 W/m^2	±10 W/m^2	Needs confirmation
Refresh	Minimum: TBD	Goal: 12 hrs	24 hrs	

3/15/95

npoess

40.45: NET SURFACE SHORTWAVE RADIATION [Derived] Absorbed solar radiation - amount of solar energy absorbed by the Earth-atmosphere system. (daily averaged estimate)				Lockheed PI: Dr. Ken Hardy
Solution Type: CERES			Risk: Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 2: CERES	REMARKS
Sensing Depth	Minimum: TBD	Goal: TBD	21 km at nadir	modeled fm point meas. net = (down - reflected) sw
Horizontal Spatial Resolution	Minimum: TBD	Goal: 100 km	250 km	Values mapped into 250 km grid
Vertical Sampling Interval	Minimum: TBD	Goal: TBD	Surface only	
Mapping Accuracy	Minimum: TBD	Goal: 10 km	~10 km	
Measurement Range	Minimum: TBD	Goal: 0-500 W/m^2	0 - 1400 W/m^2	largest over tropical oceans
Precision	Minimum: TBD	Goal: 0.1 W/m^2	1 W/m^2	
Measurement Uncertainty	Minimum: TBD	Goal: 1 W/m^2	20 W/m^2	surface classification
Refresh	Minimum: TBD	Goal: 24 hrs	24 hrs	depends on cloud climatology

3/15/95

40.48: NEUTRAL DENSITY PROFILES / NEUTRAL ATMOSPHERIC SPECIFICATION [Derived] Measurements of upper atmospheric densities and scale heights. page 1 of 2				Lockheed PI: Dr. Yam Chiu
Solution Type: NADIS			Risk: Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline EDR Attribute Values	REMARKS
Coverage	Minimum: TBD	Goal: Global	Constellation swaths only	Global coverage in the sense of model/ algorithm updates
Sensing Depth	Minimum: TBD	Goal: 90-1000 km	Emission line specific; 100 - 800 km	Goal may be possible in sense of modeling
Horizontal Spatial Resolution	Minimum: TBD	Goal: 100 km	100km along trk only; cross trk res >200 km	Model resolution >1000 km
Vertical Sampling Interval	Minimum: TBD	Goal: 5 km	5 km for instrument	Scale hgt (~20km) for model
Mapping Accuracy	Minimum: TBD	Goal: 50 km	50 km (w/GPS)	

40.46: NEUTRAL DENSITY PROFILES / NEUTRAL ATMOSPHERIC SPECIFICATION [Derived] Measurements of upper atmospheric densities and scale heights. page 2 of 2				Lockheed PI: Dr. Yam Chiu
Solution Type: NADIS			Risk: Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline EDR Attribute Values	REMARKS
Measurement Range	Minimum: TBD	Goal: 10^4-10^{16} cm^{-3} (varies with altitude)	10^5-10^{16} cm^{-3} ; line specific	Weak emissions from low density (10^4 cm^{-3}) regions get buried by background light
Precision	Minimum: TBD	Goal: 1%	15% on SDR; 30% on modeling	
Measurement Uncertainty	Minimum: TBD	Goal: ±5% up to 500 km, ±10% 500-700 km, ±15% 700-1000 km	Goal not possible; Uncertainty due to model/algorithm depending on inputs outside of NPOESS SDR: 15% 100-500 km 20% 500-1000 km EDR (models): 30%	Only some constituents can be monitored by NADIS, others are not measurable by NPOESS-type satellites
Refresh	Minimum: each orbit	Goal: each orbit	Each orbit	

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.47: OCEAN COLOR/CHLOROPHYLL [Derived] Color of ocean as seen from a distance of at least 1 meter or chlorophyll content of the water.			Lockheed PI: Dr. Keith Hutchison	
Solution Type: SeaWiFS?			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 2: SeaWiFS	REMARKS
Horizontal Spatial Resolution	Minimum:	Goal:		
1. global	TBD	1 km	1.3 km	at nadir
2. regional	TBD	0.25 km	1.3 km	at nadir
Mapping Accuracy	Minimum: TBD	Goal: TBD		
1. global	TBD	0.5 km	4 km	4 km
2. regional	TBD	0.25 km	4 km	4 km
Measurement Range	Minimum: TBD	Goal: 0-100 mg/m^3	0.05 - 50 mg/m^3	
Precision	Minimum: TBD	Goal: ±10%	±10%	
Measurement Uncertainty	Minimum: TBD	Goal: ±30%	±35%	
Refresh	Minimum: TBD	Goal: 12 hrs	24 hrs	cloud-free areas only

3/15/95

40.48: OCEAN WAVE CHARACTERISTICS [Derived] Data on the height and period/frequency of ocean waves.			Lockheed PI: Mike Davis	
Solution Type: Altimeter			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 1: Altimeter	REMARKS
Horizontal Spatial Resolution	Minimum:	Goal:		
1. global	TBD	20 km	10 km	Along track only
2. regional	TBD	0.25 km	10 km	
Mapping Accuracy	Minimum: TBD	Goal: TBD		
1. global	TBD	10 km	4 km	
2. regional	TBD	3 km	4 km	
Measurement Range	Minimum: TBD	Goal: 0.5 - 30 m (height)	0.5 - 30 m	
Precision	Minimum: TBD	Goal: 0.1 m (height)	0.3 m	
Measurement Uncertainty	Minimum: TBD	Goal: ±0.2 m	±0.6 m	
Refresh	Minimum: TBD	Goal: 6 hrs	10 - 20 days	

npoess

40.49: OZONE TOTAL COLUMN/PROFILE [Derived] page 1 of 2			Lockheed PI: Dr. Aidan Roche	
Solution Type: TES (Tropospheric Emission Spectrometer - for Tropo profile), TOMS, SAGE (Total Ozone Measurement Spectrometer, Stratospheric Aerosol/Gas Experiment for total column)			Risk: Low for column; Medium for Profile	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline EDR Attribute Values	REMARKS
Sensing Depth	Minimum: TBD	Goal: TBD	Surface	
Horizontal Spatial Resolution 1. total column 2. profile (troposphere)	Minimum: TBD TBD	Goal: 250 km 250 km	 50x50 km 50x50 km	
Vertcial Sampling Interval (Profile)(troposphere)	Minimum: TBD	Goal: 1 km	3 km	TES lists 2-6 km
Mapping Accuracy	Minimum: TBD	Goal: TBD	10%	

npoess

40.49: OZONE TOTAL COLUMN/PROFILE [Derived] page 2 of 2			Lockheed PI: Dr. Aidan Roche	
Solution Type: TOMS (column-mostly strat),SAGE (prof-strat), HIRDLS (High Resolution Dynamic Limb Sounder: prof-strat), MLS (M/W Limb Sounder: prof-strat), TES (strat and tropo),SCIAMACHY (column -mostly strat)			Baseline EDR Attribute Values	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline EDR Attribute Values	REMARKS
Measurement Range 1. total column 2. profile (0-15 km)	Minimum: 0-0.65 atm-cm 0-15 ppmv	Goal: TBD TBD	 0-0.65 atm-cm 10-150 ppbv	
Precision 1. total column 2. profile	Minimum: 1%/decade 3%/decade	Goal: 0.1%/decade 0.3%/decade	 1%/decade 3%/decade	
Measurement Uncertainty 1. total column 2. profile	Minimum: TBD TBD	Goal: 1% 3%	 3% 6%	
Refresh	Minimum: 24 hrs	Goal: TBD	24 hours	

3/15/95

npoess

40.50: PRECIPITABLE WATER [Derived] Measure of precipitable water within a specified volume of atmosphere. See 40.62 which requires both precipitable water and cloud water Also 40.23 is Cloud Liquid Water which is also included in 40.62				Lockheed PI: Dr. Ken Hardy
Solution Type: MIS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline & Low Cost EDR Attribute Values	REMARKS
Sensing Depth	Minimum: TBD	Goal: TBD	0 - 30 km	Total column only
Horizontal Spatial Resolution	Minimum: TBD	Goal: 1 km	50 km	
Vertical Sampling Interval	Minimum: TBD	Goal: TBD	30 km	
Mapping Accuracy	Minimum: TBD	Goal: TBD	7 km	
Measurement Range	Minimum: TBD	Goal: 0 - 100 mm	0 - 80 mm	
Precision	Minimum: TBD	Goal: ±1 mm	±1 mm	
Measurement Uncertainty	Minimum: TBD	Goal: ±1 mm	±1 mm ±3 mm	polar areas tropics
Refresh	Minimum: 6 hrs	Goal: less than 6 hrs	5.5 hrs for 3 satellites	Worst case with 100% coverage

3/15/95

40.51: PRECIPITATION (TYPE, RATE) [Derived] Type-identify rain vs. cloud water or ice.				Lockheed PI: Dr. Ken Hardy
Solution Type: MIS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline & Low Cost EDR Attribute Values	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 100 m	25 - 50 km	
Mapping Accuracy	Minimum: TBD	Goal: 100 m	7 km	
Measurement Range	Minimum: TBD	Goal: 0 - 200 mm/hr	0 - 60 mm/hr	60 mm/hr not exceeded at resoln of 25-50 km
Precision	Minimum: TBD	Goal: 1.0 mm/hr	1 mm/hr	
Measurement Uncertainty	Minimum: TBD	Goal: ±2 mm/hr	±5 mm/hr	
Refresh	Minimum: TBD	Goal: 3 hrs	6 hrs with 2 satellites	

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.52: PRESSURE (SURFACE/PROFILE) [Derived]			Lockheed PI: Dr. Ken Hardy	
Solution Type: MIS, Profiler Suite		Risk: Medium		
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline & Low Cost EDR Attribute Values	RE-MARKS
Sensing Depth	Minimum: TBD	Goal: Surface - 30 km	Sfc to 30 km	
Horizontal Spatial Resolution	Minimum: TBD	Goal: 5 km	50 km	
Vertical Sampling Interval	Minimum: TBD	Goal: 0.25 km increments from 0-2 km; 0.5 km increments from 2-5 km; 1.0 km increments above 5 km	1 km	Needs confirmation
Mapping Accuracy	Minimum: TBD	Goal: 10 km	7 km	
Measurement Range	Minimum: TBD	Goal: 10-1050 mb	10 - 1050 mb	
Precision	Minimum: TBD	Goal: 2 mb	2 mb	
Measurement Uncertainty	Minimum: TBD	Goal: ±3% from 0-10 km; ±5% from 10-30 km	±5% from 0-30 km	Needs confirmation
Refresh	Minimum: 12 hrs	Goal: 1 hr	11.1 hrs for 3 satellites	

3/15/95

npoess

40.53: SALINITY [Derived] page 1 of 2 A measure of the quanity of dissolved materials in sea water. A formal definitiion is "the total amount of solid materials, in grams, continaed in one kilogram of sea water, when all the carbonate has been converted to oxide, the bromine and iodine converted to chlorine, and all orgranic matter is completely oxided. Units of measurements are parts per thousand, by weight".	Lockheed PI: Dr. Ken Hardy

Solution Type: MIS. EDR not retrieved with any of the 4 alternative concepts	Risk: High

DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline & Low Cost EDR Attribute Values	REMARKS
Sensing Depth	Minimum: TBD	Goal: 0 - 300 m	N/A	
Horizontal Spatial Resolution 1. Global 2. Regional	Minimum: TBD TBD	Goal: 20 km 0.25 km	N/A	Need freq of < 2 MHz; lowest possible freq for MIS is 6.8 GHz
Vertical Sampling Interval 1. Global 2. Regional	Minimum: TBD TBD	Goal: ±10 m ±2 m	N/A	

3/15/95

npoess

40.53: SALINITY [Derived] page 2 of 2 A measure of the quanity of dissolved materials in sea water. A formal definitiion is "the total amount of solid materials, in grams, continaed in one kilogram of sea water, when all the carbonate has been converted to oxide, the bromine and iodine converted to chlorine, and all orgranic matter is completely oxided. Units of measurements are parts per thousand, by weight".				Lockheed PI: Dr. Ken Hardy
Solution Type: MIS			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline & Low Cost EDR Attribute Values	REMARKS
Mapping Accuracy 1. Global 2. Regional	Minimum: TBD TBD	Goal: 5 km 0.25 km	N/A	Need freq of < 2 MHz
Measurement Range	Minimum: TBD	Goal: 0 - 40 ppt	N/A	
Precision	Minimum: TBD	Goal: 0.1 ppt	N/A	
Measurement Uncertainty 1. Global 2. Regional	Minimum: TBD TBD	Goal: TBD 0.5 ppt	N/A	Need freq of < 2 MHz
Refresh	Minimum: TBD	Goal: 72 hr	N/A	

3/15/95

40.54: SEA SURFACE HEIGHT/TOPOGRAPHY [Derived] Longwave horizontal variation in the height of the sea surface.				Lockheed PI: Mike Davis
Solution Type: Altimeter			Risk: Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 1 Altimeter	REMARKS
Sensing Depth	Minimum: TBD	Goal: TBD	50 km	Sensing range for the altimeter
Horizontal Spatial Resolution	Minimum: TBD	Goal: 1 km	6 km	
Vertical Sampling Interval	Minimum: TBD	Goal: TBD	unk	
Mapping Accuracy	Minimum: TBD	Goal: 1 km	TBR	
Measurement Range	Minimum: TBD	Goal: $\pm 10^4$ cm	$\pm 10^4$ cm	TOPEX Data
Precision	Minimum: TBD	Goal: 2 cm	3 cm	TOPEX Data
Measurement Uncertainty	Minimum: TBD	Goal: ±5 cm	±3 cm	TOPEX Data
Refresh	Minimum: TBD	Goal: 3 hrs	75 days for 2 satellites	TOPEX Data

CONVERGENCE EFFORT MODIFICATION

40.55: SNOW COVER / DEPTH

npoess

40.55: SNOW COVER / DEPTH (Derived)				Lockheed PI: Mike Davis
Solution Type: OASIS/MIS			Risk: Low for cover; High for depth	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline & Low Cost EDR Attribute Values	REMARKS
Sensing Depth	Minimum: TBD	Goal: Determine if depth is 0 - 25 cm or >25 cm	0-40 cm	Dry snow only
Horizontal Spatial Resolution	Minimum: TBD	Goal: 1 km	25 km 1.3 km	MIS foot-prints OASIS for cover
Vertical Sampling Interval	Minimum: TBD	Goal: 12.5 cm	2 mm	Dry snow only
Mapping Accuracy	Minimum: TBD	Goal: 1 km	7 km	
Measurement Uncertainty	Minimum: TBD	Goal: ±10% for snow	±10 cm	Value to be confirmed
Refresh	Minimum: TBD	Goal: 3 hrs	12 hours	

3/15/95

40.56: SNOW WATER EQUIVALENT (Derived)				Lockheed PI: Mike Davis
Solution Type: MIS?			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline & Low Cost EDR Attribute Values	REMARKS
Sensing Depth	Minimum: TBD	Goal: TBD	Surface	
Horizontal Spatial Resolution	Minimum: TBD	Goal: 1 km	12.5 -50 km	MIS foot-prints
Vertical Sampling Interval	Minimum: TBD	Goal: TBD	N/A	
Measurement Range	Minimum: TBD	Goal: TBD	dry/wet*	2 choices only
Measurement Uncertainty	Minimum: TBD	Goal: ±10%	±25%	75% correct category
Precision	Minimum: TBD	Goal: TBD	dry or wet	
Mapping Accuracy	Minimum: TBD	Goal: 1 km	7 km	
Refresh	Minimum: TBD	Goal: 12 hrs	12 hrs	

¶
*·Dry·when·density·of·snow·is·≤0.5·times·the·density·of·water¶

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.57: SOLAR EXTREME ULTRA VIOLET (EUV) [Derived] The portion of the solar spectrum which is responsible for creation of the Earth's ionosphere as well as much of the heating of the upper atmosphere.				Lockheed PI: Dr. Yam Chiu
Solution Type: SEE (Solar EUV Emission)* EDR is not retrieved with any of the 4 alternative concepts.			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Recommended EDR Attribute Values	REMARKS
Coverage	Minimum: TBD	Goal: Global	Solar disk monitoring; not Earth related	Requires SEE on sun-pointing platform or dawn-dusk satellite
Measurement Range	Minimum: TBD	Goal: 5-200 nm	5-200 nm	
Precision	Minimum: TBD	Goal: TBD	TBD***	
Measurement Uncertainty	Minimum: TBD	Goal: TBD	TBD***	
Refresh	Minimum: TBD	Goal: TBD	N/A	

* Note: Solar EUV emissions monitoring requires a continuous solar pointing platform such as is possible only on the dawn-dusk spacecraft of NPOESS. Intermittent monitoring on any platform that enters into Earth's shadaw is good only for the long term component of solar EUV emissions which vary several-fold over durations of hours. Furthermore, repeated day-night cycling is detrimental to instrument longevity.

** The SEE instrument does not have a long-term heritage. Calibration using emissivity of EUV stars is difficult because their emissions are weak and line dominated.

*** Emission line dependent; impacted by knowledge of calibration by EUV star emissivity, and there are very few EUV stars.

3/15/95

40.58: SURFACE WIND STRESS [Derived] The frictional stress of the wind acting on the sea surface, causing it to move as a wind-drift current, and causing the formation of waves.				Lockheed PI: Dr. Ken Hardy
Solution Type: MIS, Profilers			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline & Low Cost EDR Attribute Values	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 20 km	50 km	
Vertical Sampling Interval	Minimum: TBD	Goal:	N/A	Sfc EDR
Mapping Accuracy	Minimum: TBD	Goal: 10 km	7 km	
Measurement Range	Minimum: TBD	Goal: TBD	0-10 dyn cm^{-2}*	
Precision	Minimum: TBD	Goal: ±10%	±10%*	
Measurement Uncertainty	Minimum: TBD	Goal: ±30%	±50%*	
Refresh	Minimum: TBD	Goal: 12 hrs	11.1 hours for 3 satellites	Worst case

*Values need to be confirmed.

3/15/95

40.59: TOTAL LONGWAVE RADIATION (TOP OF ATMOSPHERE) [Derived] Outgoing longwave radiation required during daytime and nighttime.			Lockheed PI: Dr. Ken Hardy	
Solution Type: CERES			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 2: CERES	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	40 km at nadir	
Mapping Accuracy	Minimum: TBD	Goal: TBD	~5 km	
Measurement Range	Minimum: TBD	Goal: 0-500 W/m^2	0 - 500 W/m^2	
Precision	Minimum: TBD	Goal: TBD	1 W/m^2	
Measurement Uncertainty	Minimum: TBD	Goal: ± 2.5 W/m^2	± 5 W/m^2	
Refresh	Minimum: 12 hrs	Goal: 6 hrs	6 hrs for 2 satellites	

npoess

40.60: TOTAL SHORTWAVE RADIATION [Derived] In-coming shortwave radiation required during daytime and nighttime.				Lockheed PI: Dr. Ken Hardy
Solution Type: CERES			Risk: Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 2: CERES	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 10 km	40 km at nadir	Incoming = Surface ?
Mapping Accuracy	Minimum: TBD	Goal: TBD	~ 5 km	
Measurement Range	Minimum: TBD	Goal: 0-500 W/m^2	0 - 1400 W/m^2	Assume incoming at top of atm
Precision	Minimum: TBD	Goal: TBD	1 W/m^2	
Measurement Uncertainty	Minimum: TBD	Goal: $\pm$2.5 W/m^2	10 W/m^2	Modeled
Refresh	Minimum: 12 hrs	Goal: 6 hrs	6 hrs for 2 satellites	

3/15/95

npoess

40.61: TOTAL SOLAR IRRADIANCE (FULL SPECTRUM) [Measured] Incident radiation measurements.				Lockheed PI: Dr. Ken Hardy
Solution Type: ACRIM. The ACRIM is not included in any of the 4 Alternative Concepts			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Recommended EDR Attribute Values	REMARKS
Measurement Range	Minimum: 0 - 1400 W/m^2	Goal: TBD	0 - 1400 W/m^2	
Precision	Minimum: TBD	Goal: TBD	0.0005/year%	
Measurement Uncertainty	Minimum: TBD	Goal: $\pm$2.5 W/m^2	$\pm$1.4 W/m^2	
Refresh	Minimum: 24 hrs	Goal: TBD	6 hrs for 2 satellites	

40.62: TOTAL WATER CONTENT [Derived] Measure of moisture in a given volume of the atmosphere.				Lockheed PI: Mike Davis
Solution Type: MIS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	**SPECIFICATIONS**		**Baseline & Low Cost EDR Attribute Values**	**REMARKS**
Horizontal Spatial Resolution	Minimum: 50 km	Goal: 30 km	50 km	
Vertical Sampling Interval	Minimum: TBD	Goal: 1 km	Surface to 10 km	
Measurement Uncertainty	Minimum: CLWC: ±0.1 kg/m^2 over ocean only TIWC: ±3.0 kg/m^2 1 km	Goal: TBD	CLWC: ±0.06 kg/m^2 TIWC: ±3.0 kg/m^2	Over oceans only
Refresh	Minimum: 12 hrs	Goal: 3 hrs	12 hrs	

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.62: TOTAL WATER CONTENT [Derived] Measure of moisture in a given volume of the atmosphere.				Lockheed PI: Mike Davis
Solution Type: MIS			Risk: Low	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	**SPECIFICATIONS**		**Baseline & Low Cost EDR Attribute Values**	**REMARKS**
Horizontal Spatial Resolution	Minimum: 50 km	Goal: 30 km	50 km	
Vertical Sampling Interval	Minimum: TBD	Goal: 1 km	Surface to 10 km	
Measurement Uncertainty	Minimum: CLWC: ± 0.1 kg/m^2 over ocean only TIWC: ± 3.0 kg/m^2 1 km	Goal: TBD	CLWC: ± 0.06 kg/m^2 TIWC: ± 3.0 kg/m^2	Over oceans only
Refresh	Minimum: 12 hrs	Goal: 3 hrs	12 hrs	

40.63: TROPOSPHERIC WINDS [Derived] Page 1 of 2 Wind measured throughout the atmosphere.			Lockheed PI: Dr. Ken Hardy	
Solution Type: Profilers			Risk: Low for Geostrophic Winds; High for true winds	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline & Low Cost EDR Attribute Values	REMARKS
Sensing Depth	Minimum: TBD	Goal: Sfc to 20 km	Sfc to 20 km	Geostrophic
Horizontal Spatial Resolution	Minimum: TBD	Goal: 50 km	200 km	Geostrophic
Vertical Sampling Interval	Minimum: TBD	Goal: 0.1 km	2-5 km	Geostrophic
Mapping Accuracy	Minimum: TBD	Goal: 10 km	20 km	

npoess

40.63: TROPOSPHERIC WINDS [Derived] Page 2 of 2 Wind measured throughout the atmosphere.			Lockheed PI: Dr. Ken Hardy	
Solution Type: Profilers			Risk: Low for Geostrophic Winds; High for true winds	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline & Low Cost EDR Attribute Values	REMARKS
Measurement Range	Minimum: TBD	Goal: speed 0-100 m/s	0-100 m/s	Geostrophic
Precision	Minimum: TBD	Goal: speed 0.5 m/s in each horizontal vector component	±1 m/s	Geostrophic
Measurement Uncertainty	Minimum: TBD	Goal: speed ±1 m/s in each horizontal vector component	±10 m/s (1σ)	Geostrophic
Refresh	Minimum: 12 hrs	Goal: 1 hr	12 hrs	

3/15/95

npoess

40.64: TURBIDITY [Derived] Measure of suspended matter in the ocean.			Lockheed PI: Dr. Keith Hutchison	
Solution Type: SeaWiFS			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 2: SeaWiFS	REMARKS
Sensing Depth	Minimum: TBD	Goal: TBD	~ 20 m	
Horizontal Spatial Resolution	Minimum: TBD	Goal: 0.25 km	1.3 km	
Mapping Accuracy	Minimum: TBD	Goal: 0.25 km	4 km	
Measurement Range	Minimum: TBD	Goal: 0 - 100 mg/L	0 - 50 mg/L	
Precision	Minimum: TBD	Goal: 0.1 mg/L	5 classes; 0 - 5, 5 - 10, 10 - 25, 25 - 50, > 50 mg/L	assumes info on bottom spectral pigment char. are known
Measurement Uncertainty	Minimum: TBD	Goal: ±0.1 mg/L	± 1 class	
Refresh	Minimum: TBD	Goal: 24 hrs	24 hrs from near noon satellite	Cloud-free areas only

3/15/95

CONVERGENCE EFFORT MODIFICATION

npoess

40.65: VEGETATION/SURFACE TYPE [Derived] Predominant vegetation type in a given area, coupled with type of soil.				Lockheed PI: Mike Davis
Solution Type: OASIS/MIS			Risk: Medium	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		Baseline & Low Cost EDR Attribute Values	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 1.0 km global, 0.25 km coastal	1.3 km OASIS 50 km MIS	
Mapping Accuracy	Minimum: TBD	Goal: 1 km	4 km OASIS 7 km MIS	
Measurement Range	Minimum: TBD	Goal: identify 20 surface types, 0-100% vegetation	x classes, ice, snow, water, vegetated land	Merge into EO/IR/MW classification
Precision	Minimum: TBD	Goal: 0.1%	1 % albedo with OASSIS	
Measurement Uncertainty	Minimum: TBD	Goal: ±2%	90 % probability of correct class	
Refresh	Minimum: 12 hrs	Goal: 3 hrs	24 hrs from near noon satellite	

3/15/95

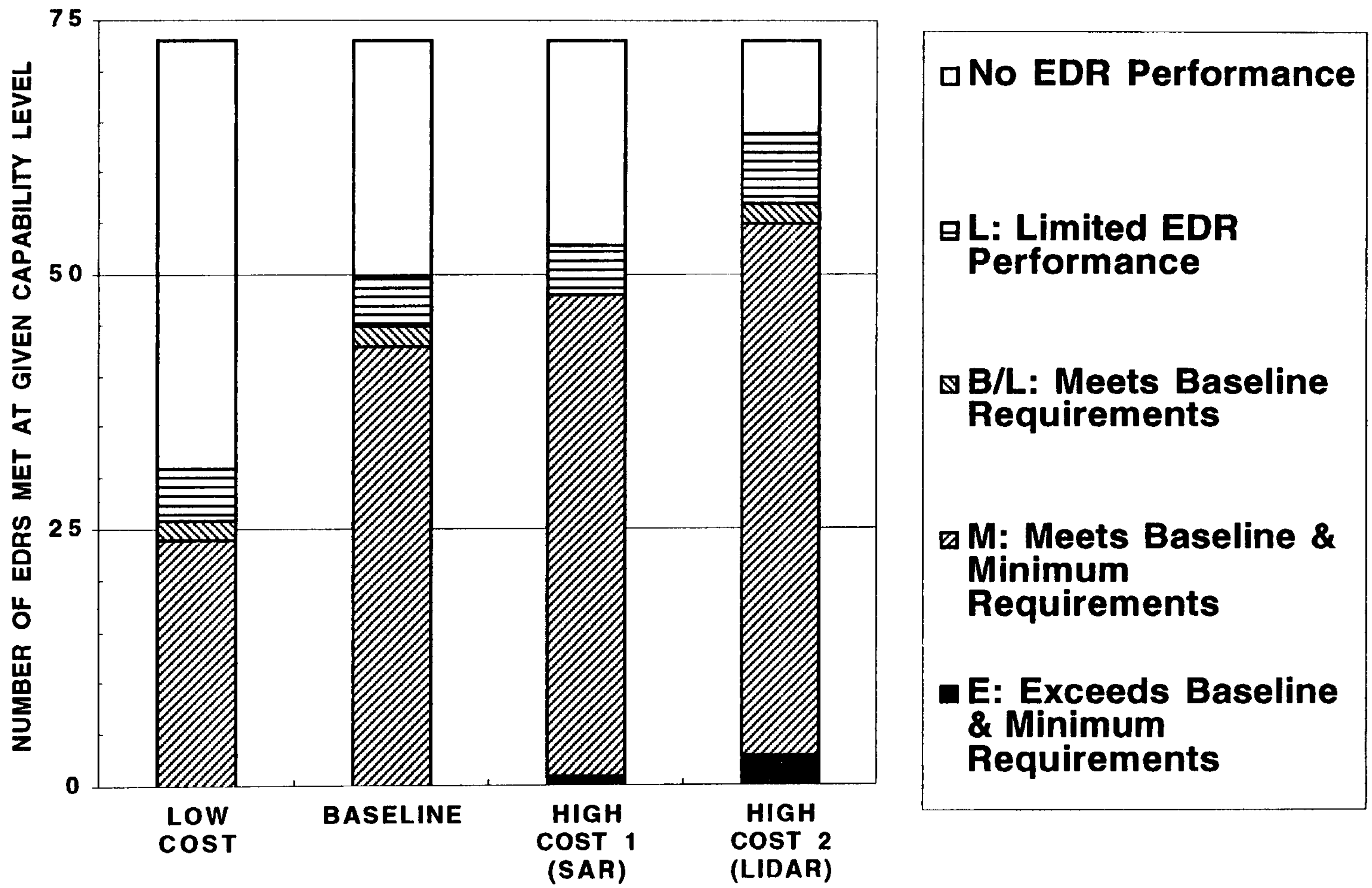
40.68: WAVE SPECTRAL ENERGY [Derived] The wave energy of ocean surface gravity waves as a function of wave number and direction.				Lockheed PI: Mike Davis
Solution Type: Altimeter and or SAR?			Risk: High	
DATA REQUIREMENTS (APPENDIX D, 1/11/95)	SPECIFICATIONS		High Cost 1: Altimeter &/or SAR	REMARKS
Horizontal Spatial Resolution	Minimum: TBD	Goal: 50 km Global; 10 km regional	250 km	25 km with SAR
Mapping Accuracy	Minimum: TBD	Goal: 25 km Global; 5 km regional	10 km	
Measurement Range	Minimum: TBD	Goal: TBD	0 - 360 deg for dir; 0 - 20 m for wave height	
Precision	Minimum: TBD	Goal: TBD	±20 deg for dir ±25% for wave height	
Measurement Uncertainty	Minimum: TBD	Goal: ±15%	±20 deg for dir ±25% for wave height	
Refresh	Minimum: TBD	Goal: 6 hrs	~12 hrs with one satellite	

3/15/95

CONVERGENCE EFFORT MODIFICATION

EDR CAPABILITY FOR NPOESS ALTERNATIVES

npoess

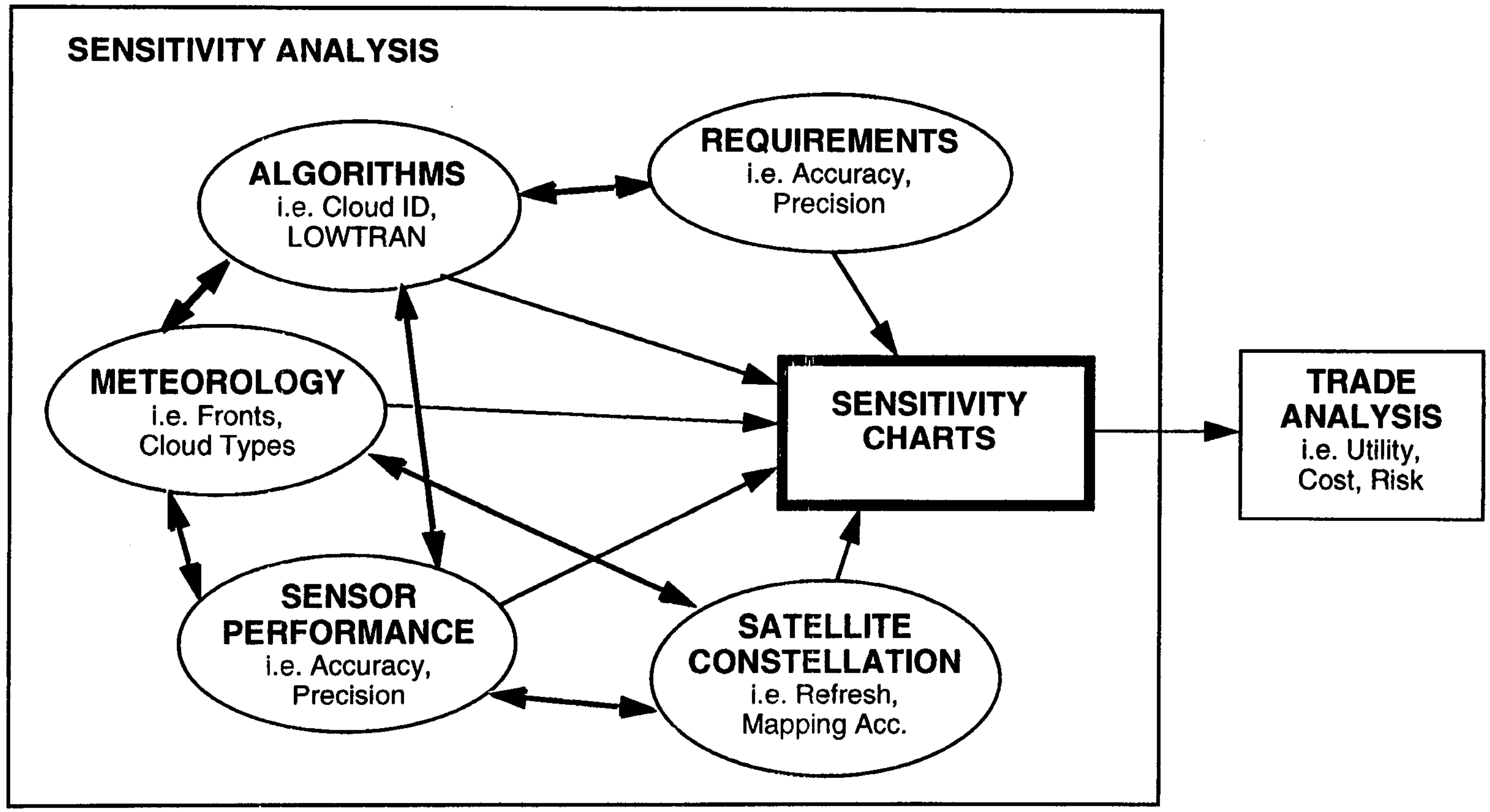


3/15/95

SENSITIVITY ANALYSIS

C. STEINKOPFF

SENSITIVITY ANALYSIS INPUTS



SENSITIVITY ANALYSIS RESOLVES COMPLICATED INTER-RELATIONSHIPS

3/15/95

PROCEDURE

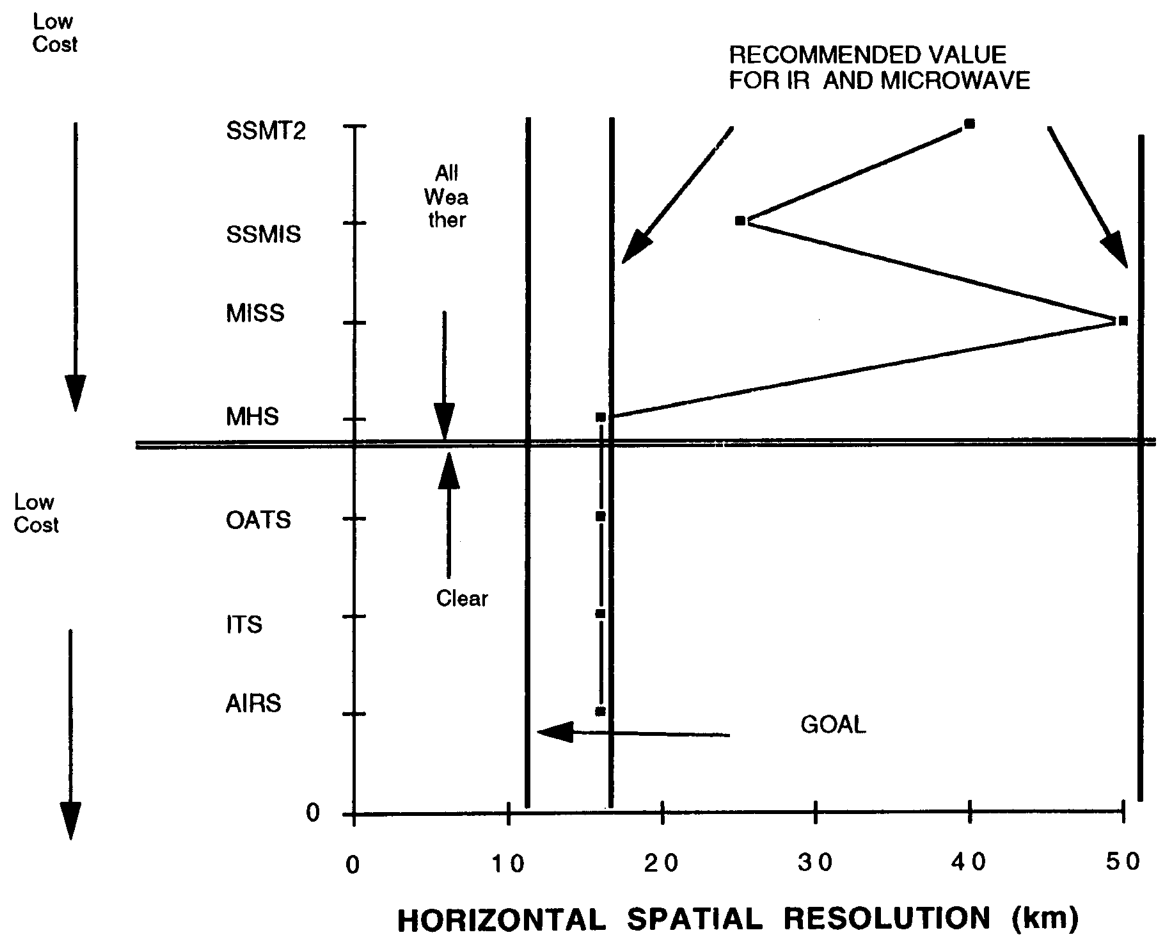
FOR EACH KEY PARAMETER:

- SELECTED CANDIDATE SENSORS
- LISTED SENSORS IN COST ORDER WHERE POSSIBLE
- PLOTTED SENSOR CAPABILITIES FOR EACH ATTRIBUTE
- PLOTTED SPEC VALUES (MIN AND GOAL)
- PLOTTED RECOMMENDED VALUE(S)
- PLOTTED ALL-WEATHER / CLEAR LINE

CONVERGENCE EFFORT MODIFICATION

SAMPLE SENSITIVITY CHART

npoess



3/15/95

CONVERGENCE EFFORT MODIFICATION

KEY PARAMETER SENSITIVITY STATUS

npoess

Parameter	No. Attributes	No. Completed	Remarks
40.1 Atmospheric Vertical Moisture Profile	5	4	Additional Simulation
40.2 Atmospheric Vertical Temperature Profile	5	5	Additional Reviews
40.3 Cloud Imagery	3	3	Cloud Typing
40.4 Sea Ice	20	9	Additional Reviews
40.5 Sea Surface Temperature	8	5	Additional Reviews
40.6 Sea Surface Winds	6	5	Additional Reviews
40.7 Soil Moisture	6	4	Additional Reviews

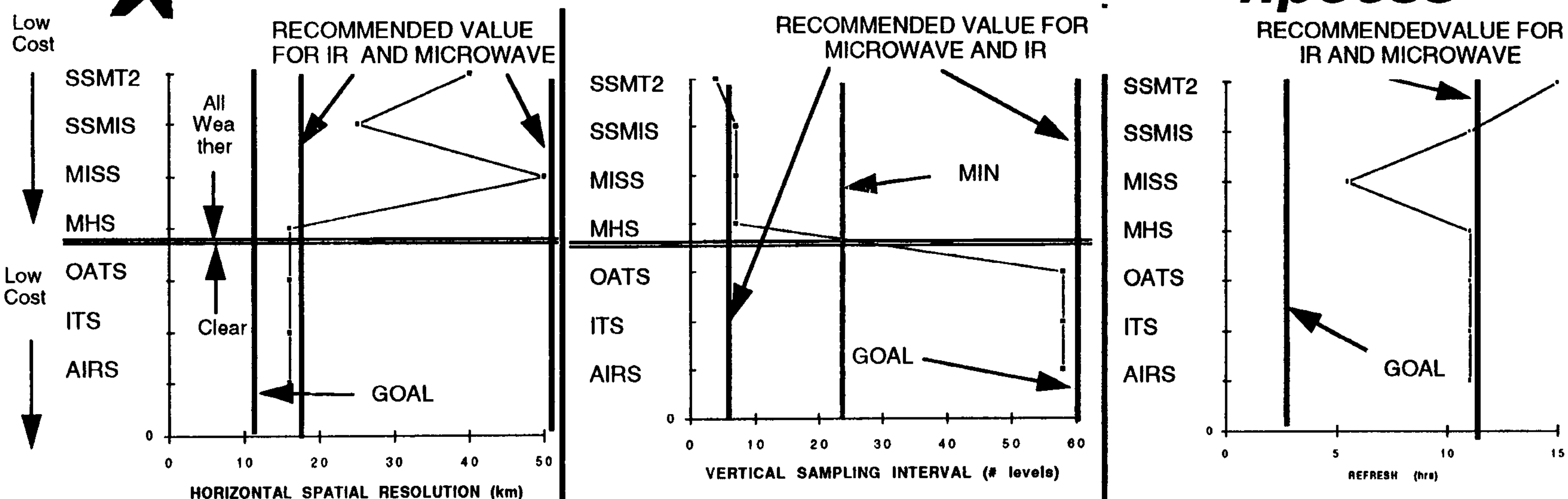
3/15/95

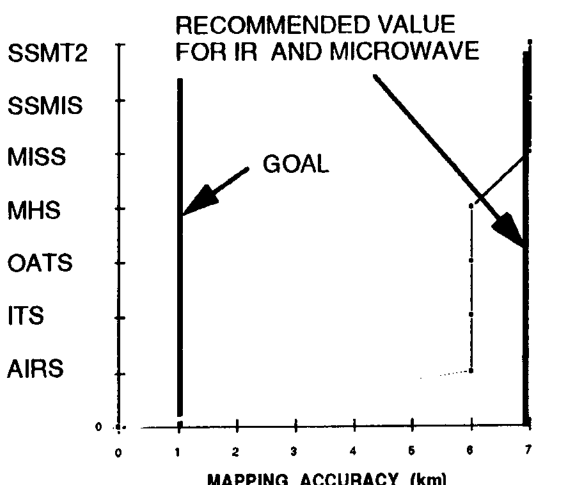
CONVERGENCE EFFORT MODIFICATION

40.1 VERTICAL MOISTURE PROFILE

Meets Requirements

npoess





DEFINITION: Moisture profiles (relative and absolute humidity - mass of water vapor per unit volume of air) throughout the troposphere where moisture is normally measured via radiosonde.

FUTURE TASKS:

1. Chart Measurement Uncertainty Attribute in % RH
2. Review Vertical Temperature Profile effect in algorithm
3. Review meteorological effects at edge-of-scan

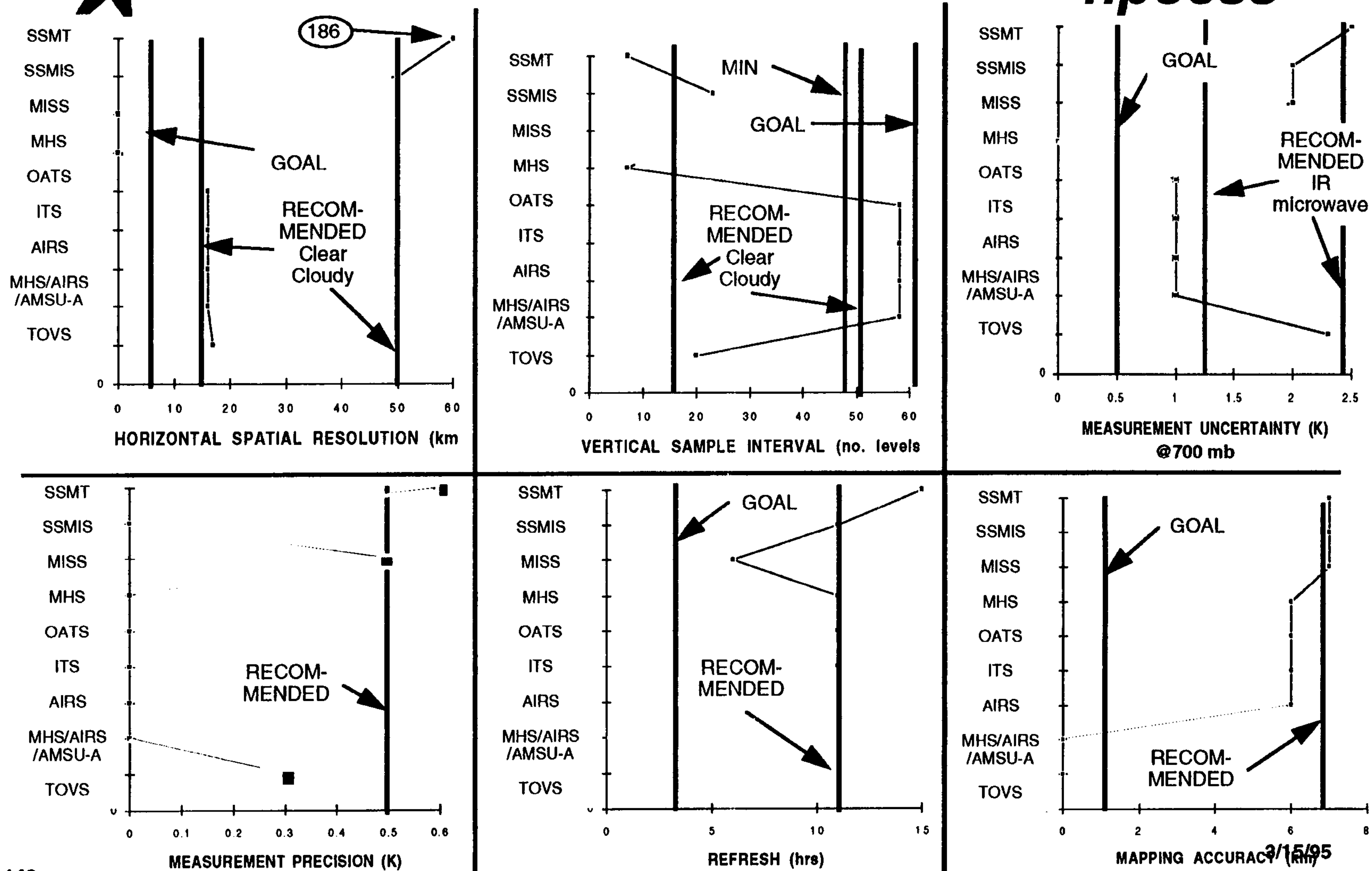
3/15/95

CONVERGENCE EFFORT MODIFICATION

40.2 VERTICAL TEMPERATURE PROFILE

Meets Requirements

npoess



3/15/95

40.2 VERTICAL TEMPERATURE PROFILE (cont.)

FUTURE TASKS:

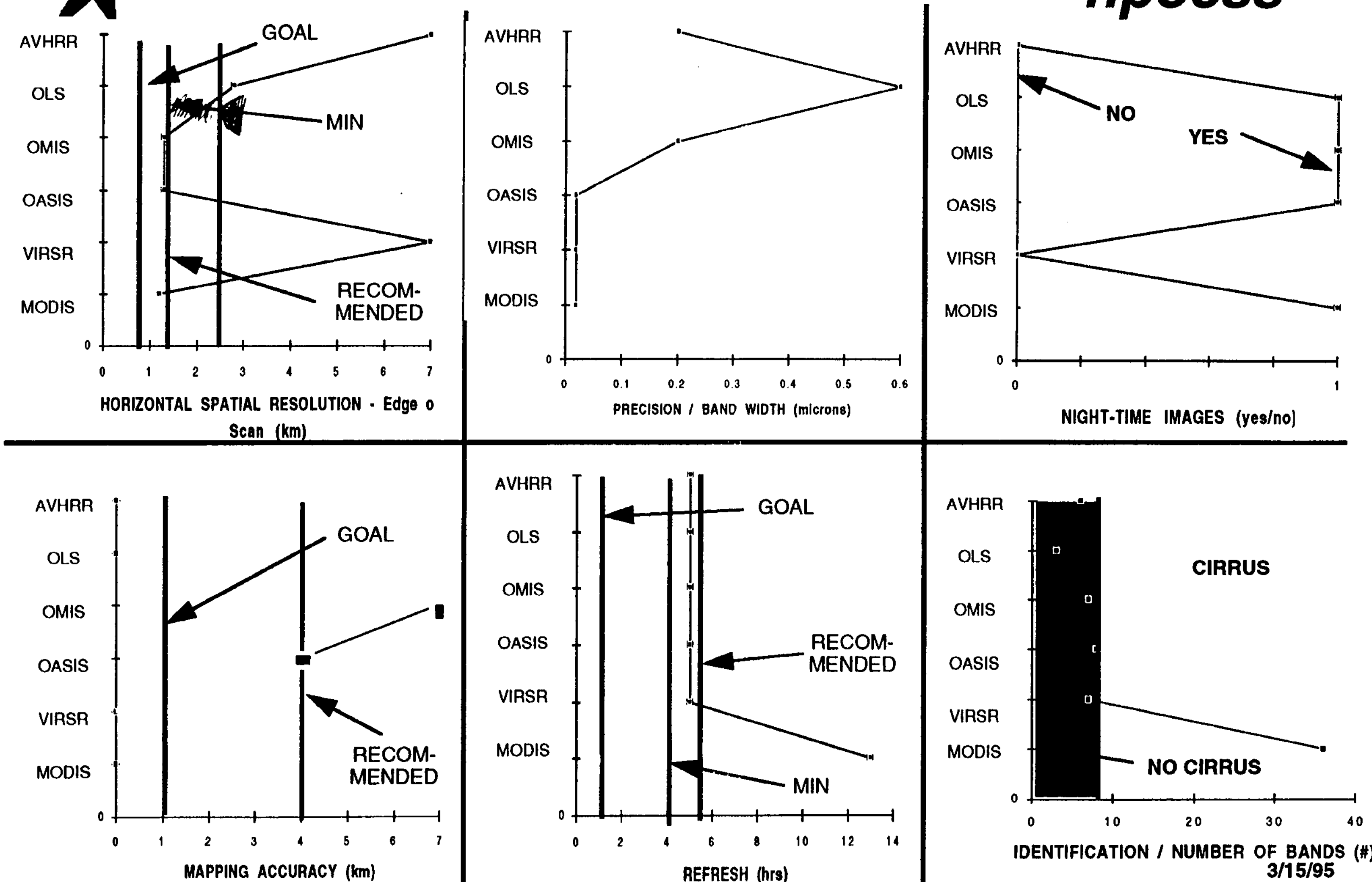
1. Review water vapor effects in algorithm
2. Review meteorological effects at edge-of-scan

CONVERGENCE EFFORT MODIFICATION

40.3 CLOUD IMAGERY

Meets Requirements

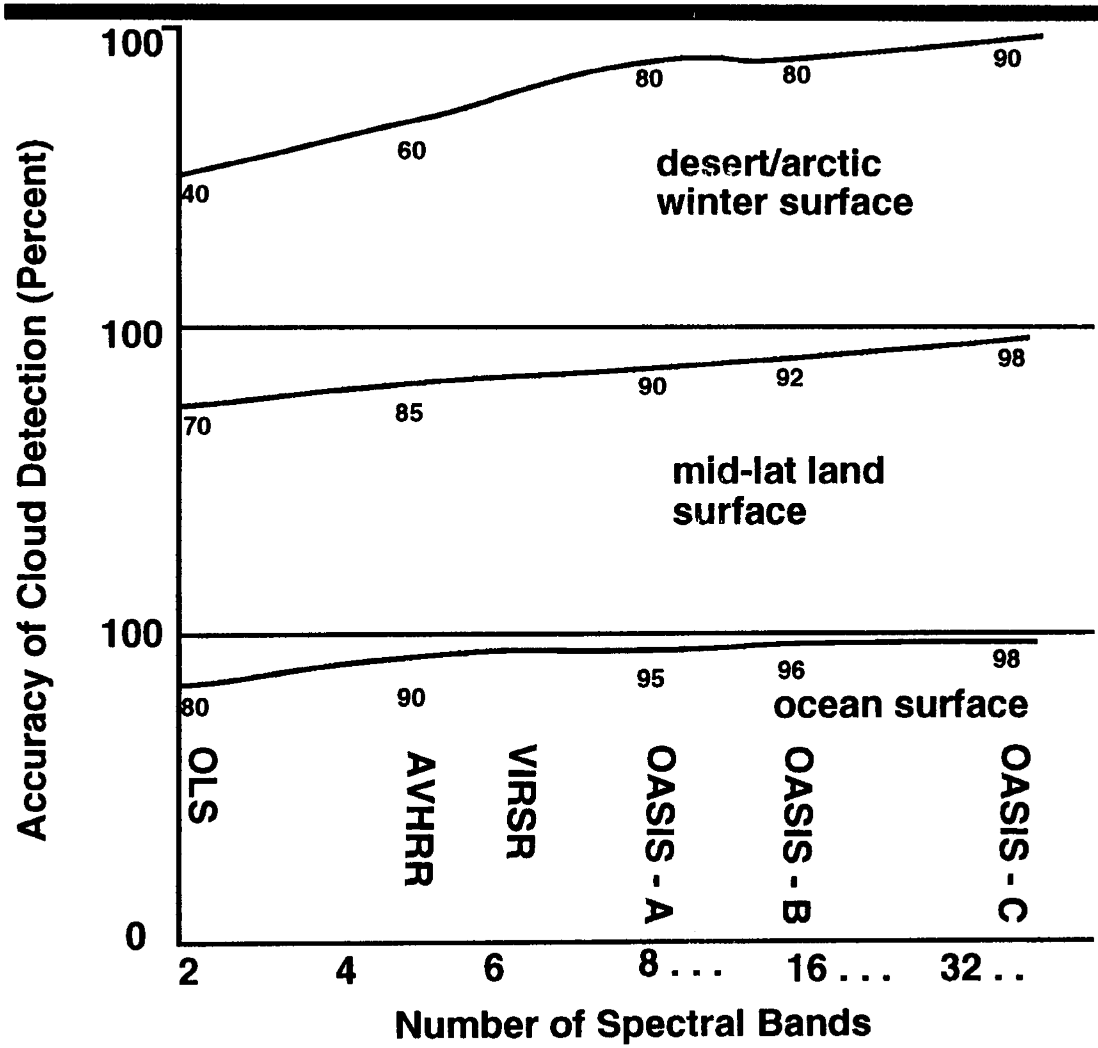
npoess



3/15/95

CLOUD COVER ACCURACY AND NUMBER OF BANDS

npoess



3/15/95

40.3 CLOUD IMAGERY (cont.)

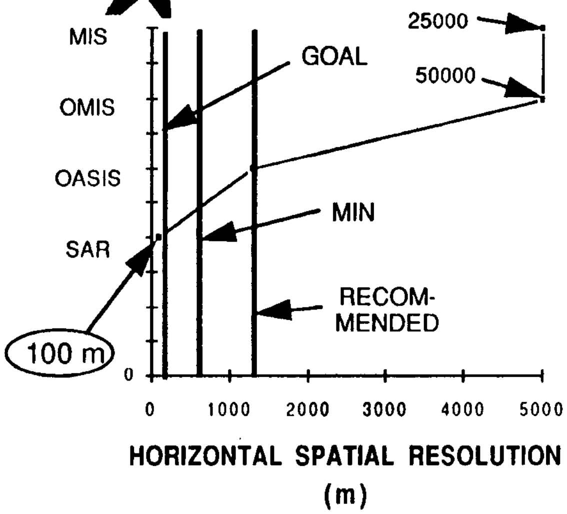
FUTURE TASKS:

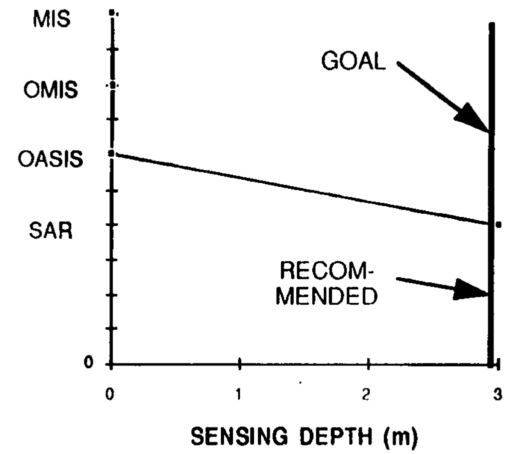
1. Review Vertical Moisture Profile effect in algorithm

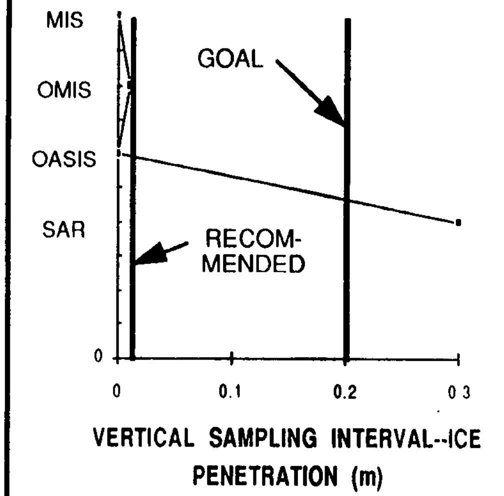
CONVERGENCE EFFORT MODIFICATION

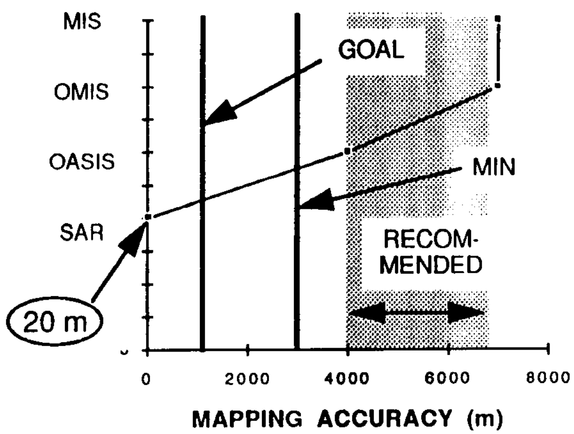
40.4 SEA ICE

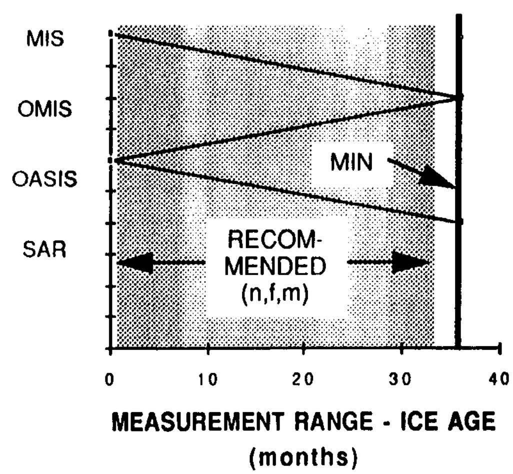
npoess

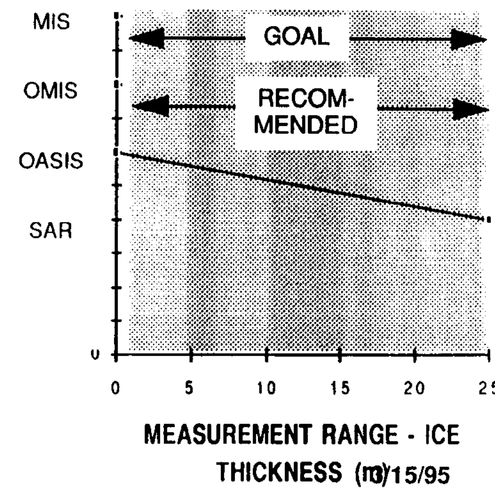








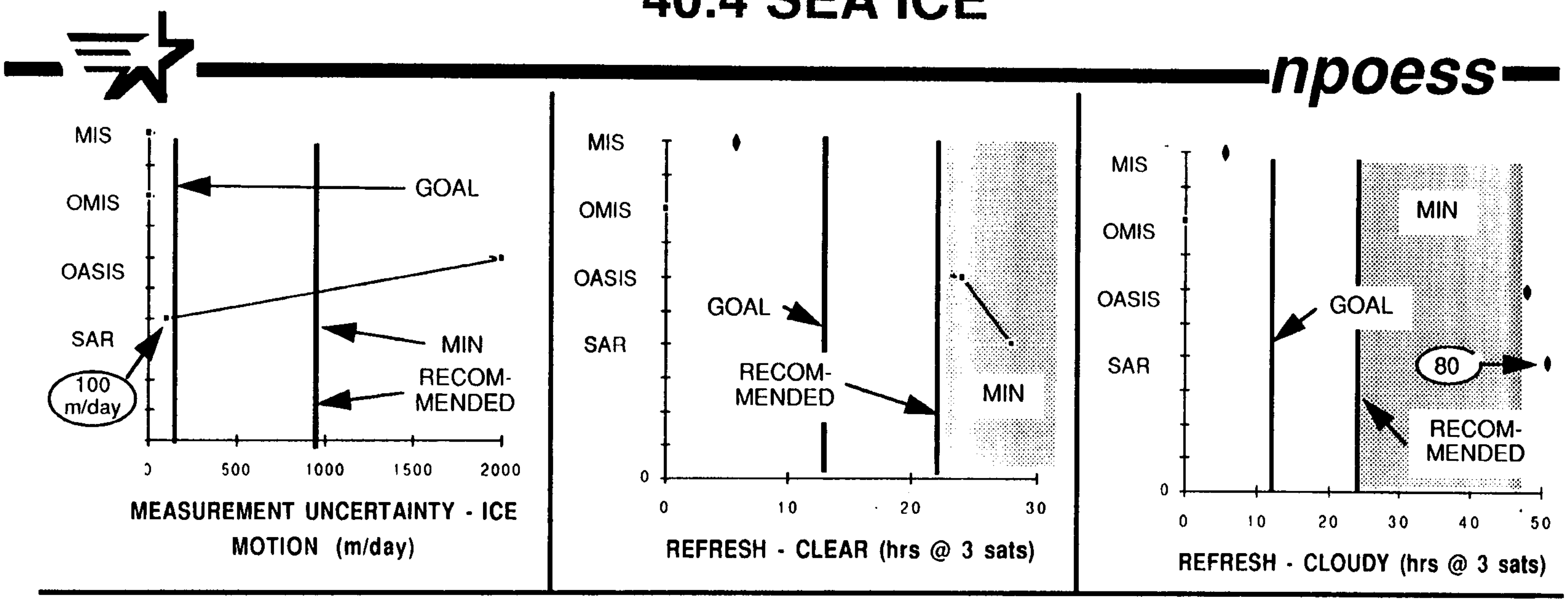




3/15/95

CONVERGENCE EFFORT MODIFICATION

40.4 SEA ICE



FUTURE TASKS:

1. Chart the remaining 11 Attributes
2. Review Algorithms for other parameters
3. Review meteorological effects on attributes

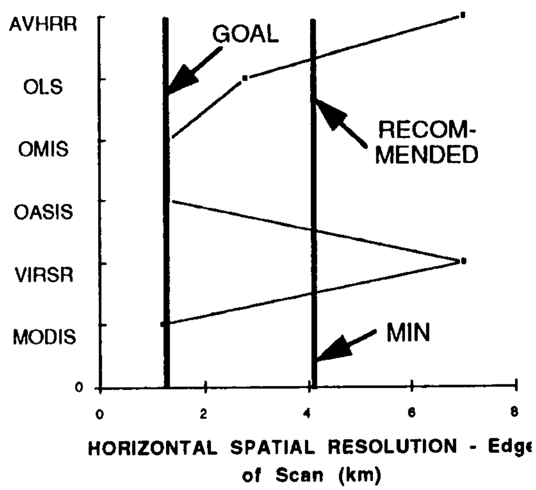
3/15/95

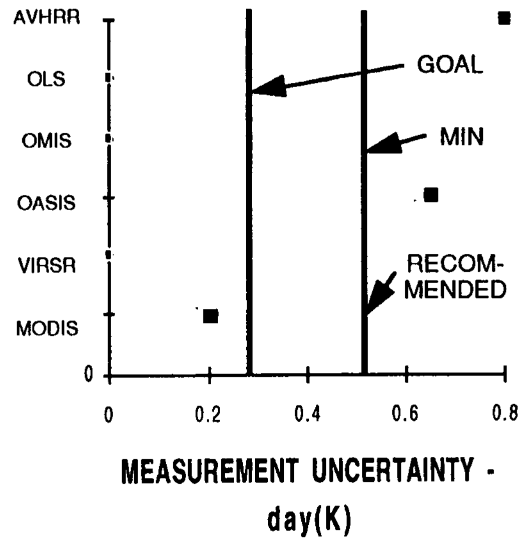
CONVERGENCE EFFORT MODIFICATION

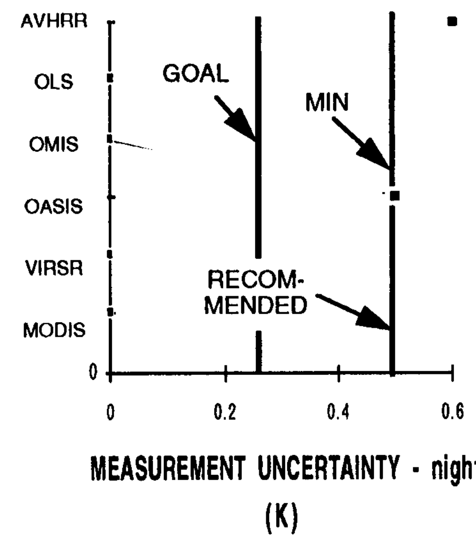
40.5 SEA SURFACE TEMPERATURE

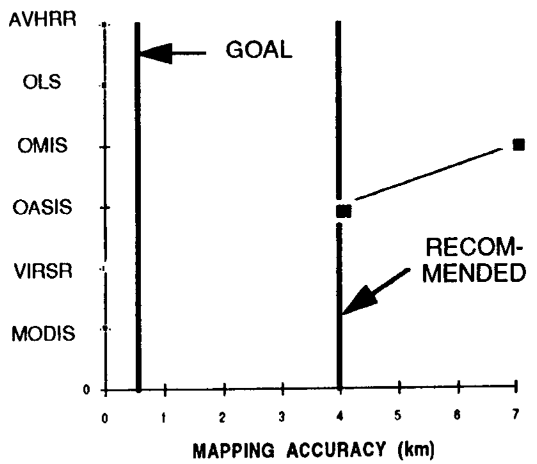
Meets Requirements

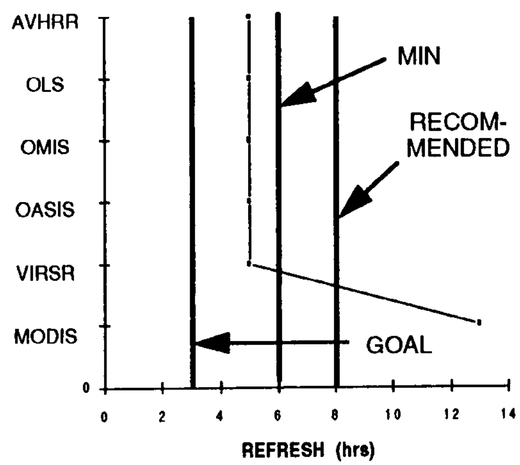
npoess











FUTURE TASKS:

1. Review algorithms
2. Review meteorological effects

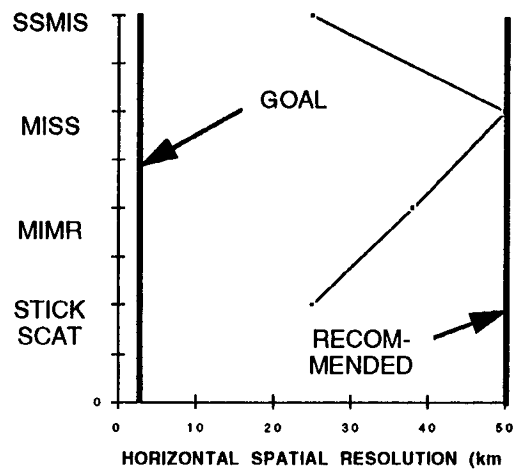
3/15/95

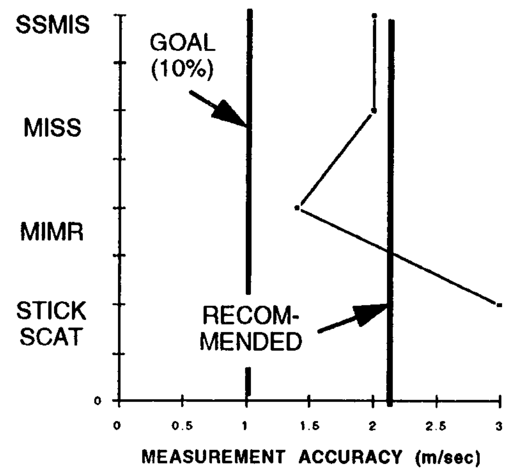
CONVERGENCE EFFORT MODIFICATION

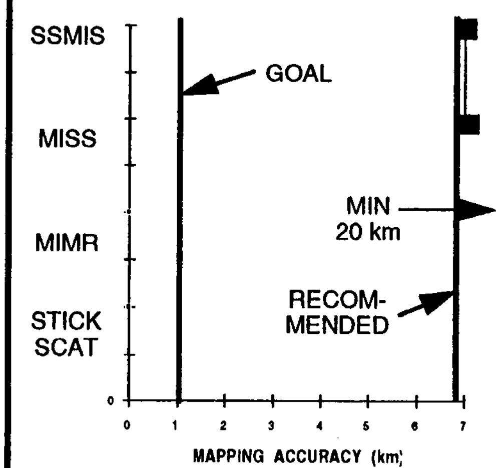
40.6 SEA SURFACE WINDS

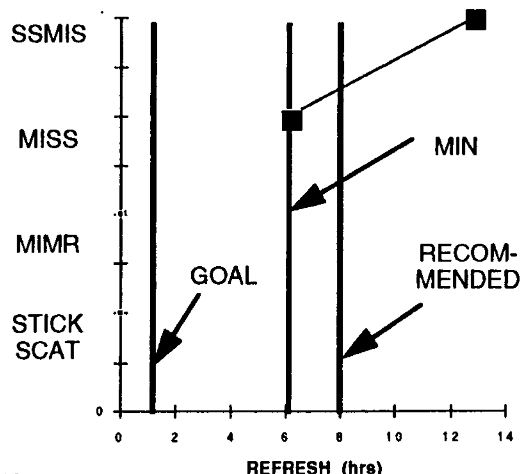
Meets Requirements

npoess









FUTURE TASKS:

1. Chart Measurement Uncertainty (direction)
2. Review algorithm
3. Review meteorological effects on attributes

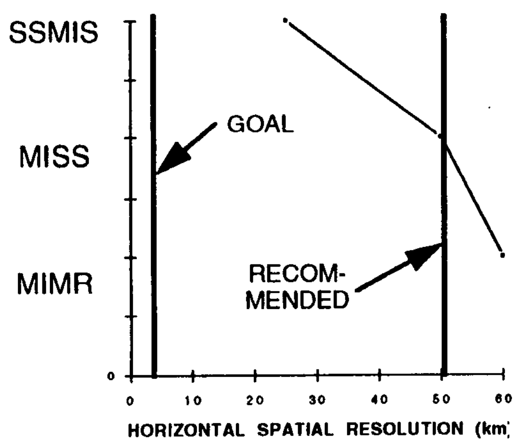
3/15/95

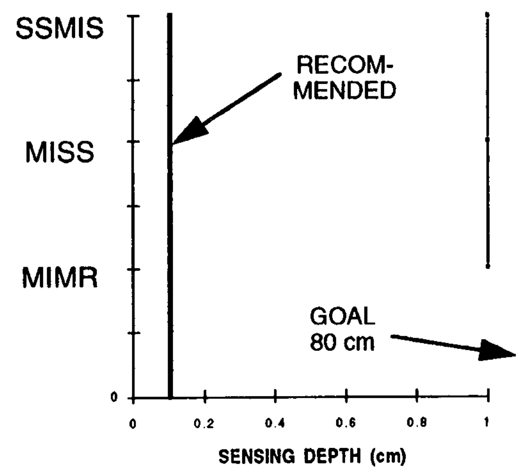
CONVERGENCE EFFORT MODIFICATION

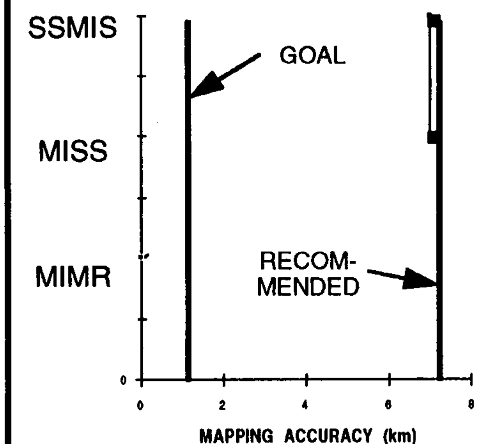
40.7 SOIL MOISTURE

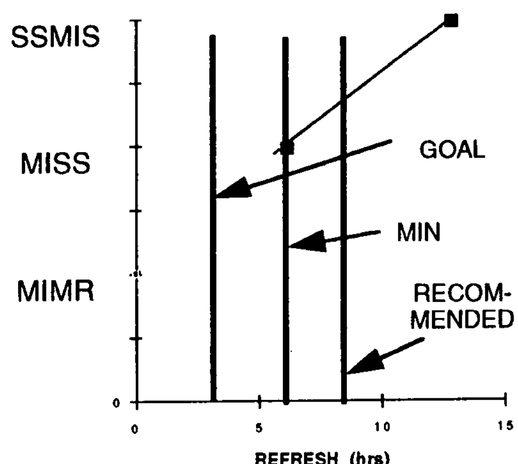
Meets Requirements

npoess









FUTURE TASKS:
1. Review algorithm
2. Review meteorological effects

3/15/95

KEY PARAMETER FUTURE PLANS / SCHEDULE

npoess

- ATTRIBUTES THAT REQUIRE SIMULATION MODELING SUCH AS REFRESH WILL BE COMPLETED BY 3/31/95
- ATTRIBUTES THAT REQUIRE ALGORITHM ANALYSIS SUCH AS MEASUREMENT UNCERTAINTY WILL BE COMPLETED BY 5/15/95
- ATTRIBUTES THAT REQUIRE METEOROLOGICAL SENSITIVITY ANALYSIS SUCH AS HORIZONTAL AND VERTICAL RESOLUTION WILL BE COMPLETED BY 7/15/95
- UTILITY, COST AND RISK CAN BE DETERMINED TO AID IN THE FINAL SELECTION

CONSTELLATION SYSTEM ENGINEERING STUDIES AND REFRESH RESULTS

JEFF HARRISON

- CONSTELLATION SATELLITE/PAYLOAD CONFIGURATION
- REFRESH SENSITIVITY TO COVERAGE
- NODAL CROSSING TIME ANALYSIS

CONSTELLATION SATELLITE/PAYLOAD REQUIREMENTS

CONVERGENCE EFFORT MODIFICATION

PHENOMENOLOGICAL CONSIDERATIONS

npoess

- 70 DEG EIA AT EDGE OF SWATH CONSIDERED UPPER LIMIT FOR CLOUD IMAGERY REFRESH; BREAKPOINT FOR ADDING ANOTHER SATELLITE
- CURRENT STATE OF THE ART SOUNDING TECHNOLOGY USES 60 DEG EIA AT EDGE OF SWATH
- ATMOSPHERIC PROCESSES REQUIRE MEASUREMENTS AT SEVERAL LOCAL TIMES EACH DAY; MAY ENCOUNTER NON-EQUILIBRIUM CONDITIONS AT DAWN/DUSK
- ULTRAVIOLET MEASUREMENTS NEED TO BE TAKEN IN AFTERNOON
- MULTIPLE SES SUITES NEEDED TO ACQUIRE MULTIPLE DATA POINTS
- CLOUD COVER OVER LAND TENDS TO BE AT A MINIMUM DURING MORNING
- OCEAN PROCESSES NEED MEASUREMENTS NEAR MAXIMUM SOLAR ILLUMINATION WITHOUT SUNGLINT
- BIOLUMINESCENCE CAN ONLY BE OBSERVED AT NIGHTTIME

3/15/95

CONVERGENCE EFFORT MODIFICATION

PHASE 0 BASELINE CONSTELLATION REFRESH PERFORMANCE

npoess

DRIVING EDR	REFRESH REQUIREMENT	SENSOR (NO.)	REFRESH PERFORMANCE
CLOUD IMAGERY	4 HRS	OASIS (3)	5 HRS
ATMOSPHERIC TEMP PROFILE	TBD	MICROWAVE/IR SOUNDERS (3)	11.1 HRS
ATMOSPHERIC MOISTURE PROFILE	TBD	MICROWAVE SOUNDER (3)	11.1 HRS
SEA SURFACE WINDS	6 HRS	MICROWAVE IMAGER (3)	5.5 HRS
SOIL MOISTURE	6 HRS	MICROWAVE IMAGER (3)	5.5 HRS
OZONE COLUMN/PROFILE	24 HRS	SBUV/TOMS (1)	38 HRS
SPACE ENVIRONMENT	VARIED	SES (3)	MEETS REQ'TS

3/15/95

PHASE 0 BASELINE CONSTELLATION CONFIGURATION

npoess

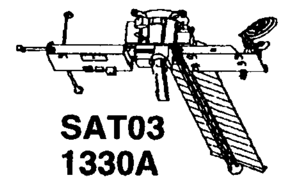
SAT01
0530A

OASIS (8 Channels)
MICROWAVE IMAGER
MICROWAVE SOUNDERS
IR SOUNDER
GPS Receiver
SES (2)
Surface Data Collection
Search and Rescue

METOP-3 (1)

SAT02
0930D

OASIS (8 Channels)
MICROWAVE IMAGER (3)
MICROWAVE SOUNDERS (3)
IR SOUNDER (3)
GPS Receiver
SES (2)



SAT03
1330A

OASIS (8 Channels)
MICROWAVE IMAGER
MICROWAVE SOUNDERS
IR SOUNDER
GPS Receiver
SES (2)
SBUV/TOMS
Surface Data Collection
Search and Rescue

(1) NPOESS INSTRUMENTS ONLY
(2) SES INCLUDES MEPS, NADIS, ABIS, RPAD, HEPS, VECMAG
(3) MAY USE METOP INSTRUMENTS IF APPROPRIATE (EX. MIMR, IASI)

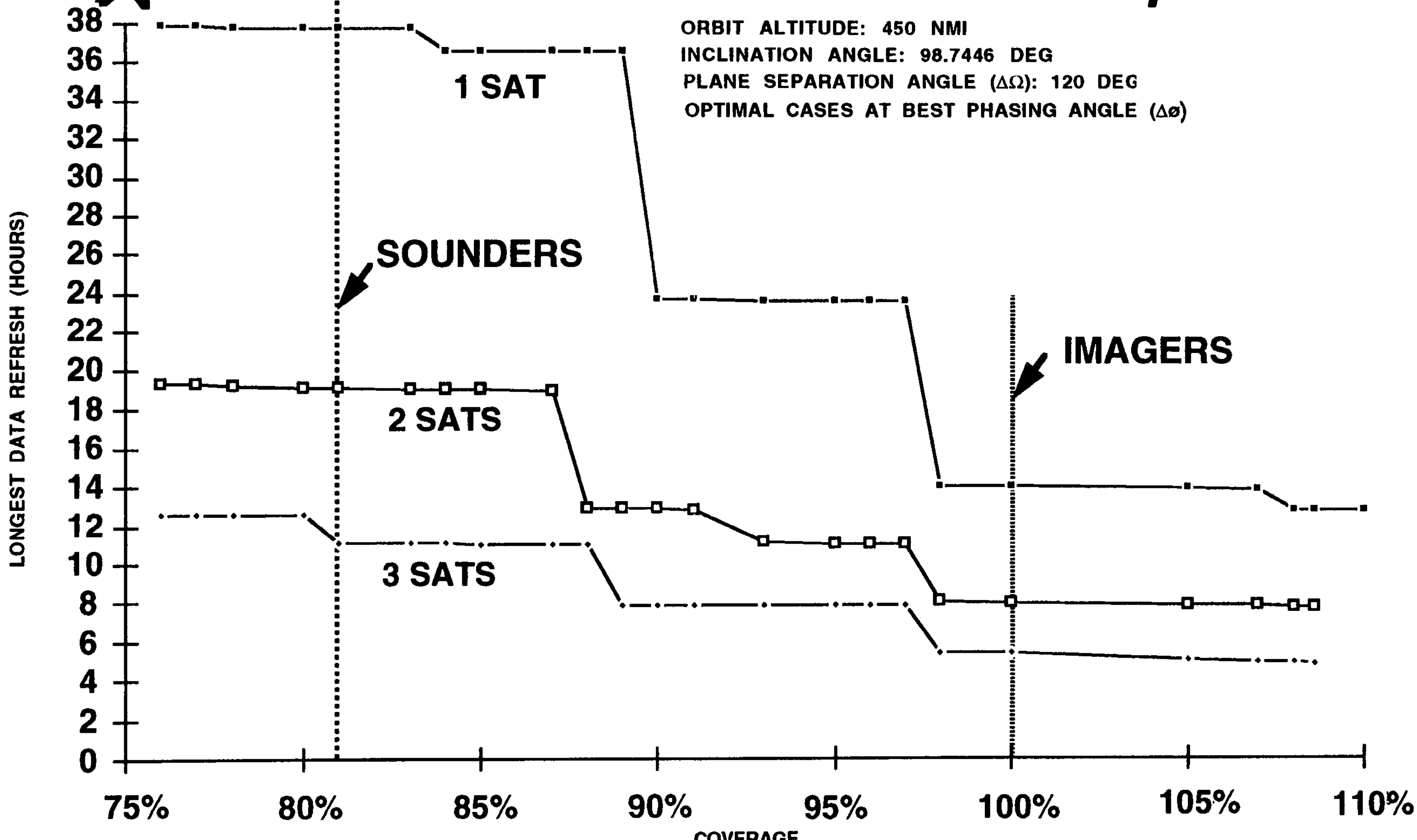
3/15/95

REFRESH SENSITIVITY TO COVERAGE

CONVERGENCE EFFORT MODIFICATION

LONGEST REFRESH VS COVERAGE (OPTIMAL CASES)

npoess



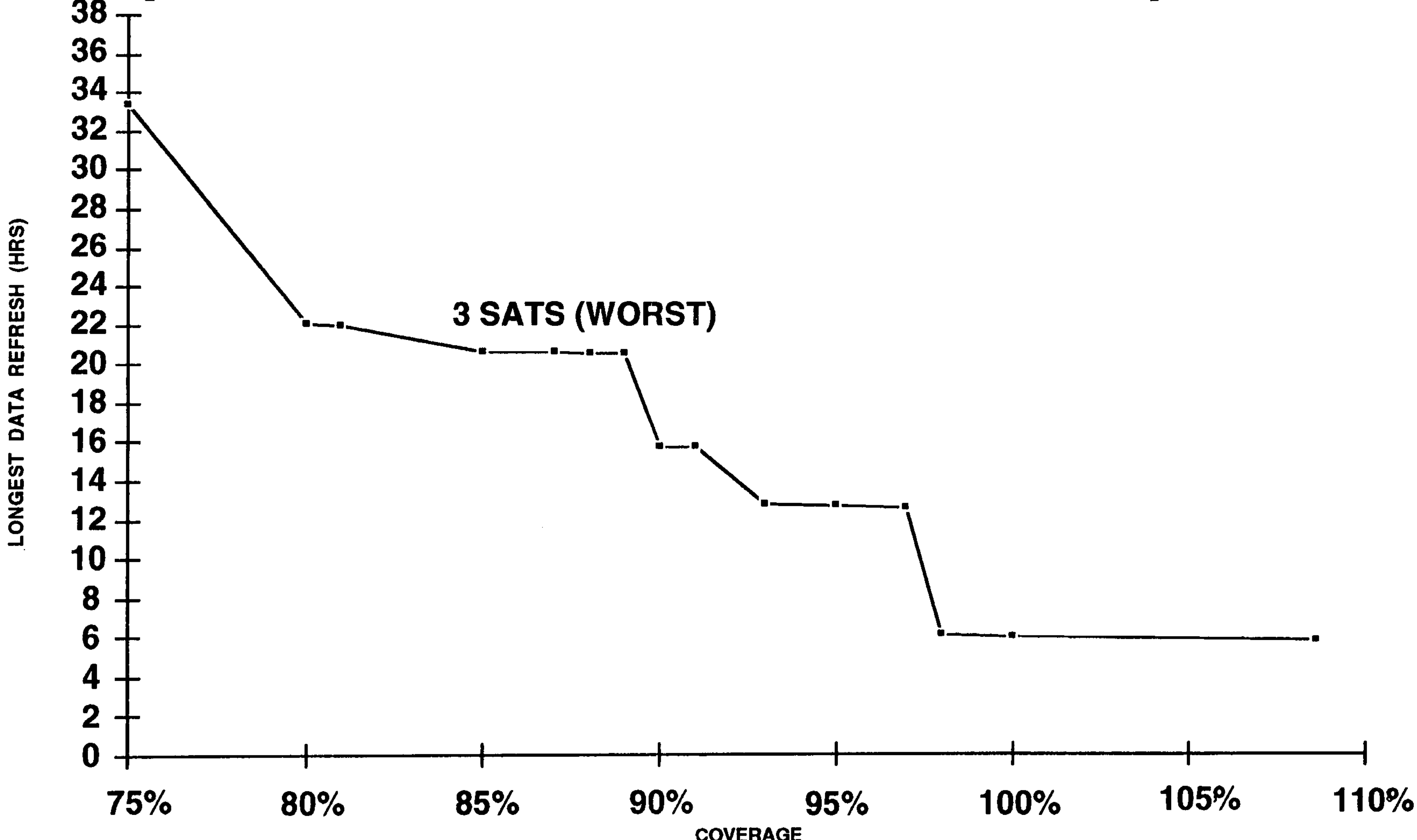
3/15/95

⊗ overlay on previous chart

CONVERGENCE EFFORT MODIFICATION

WORST CASE REFRESH VS COVERAGE (3 SATELLITES)

npoess



3/15/95

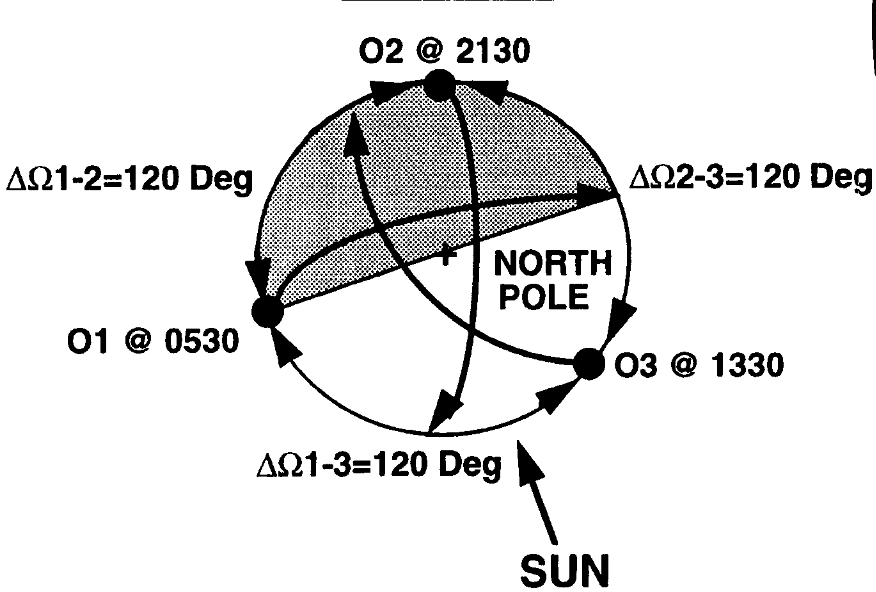
NODAL CROSSING TIME ANALYSIS

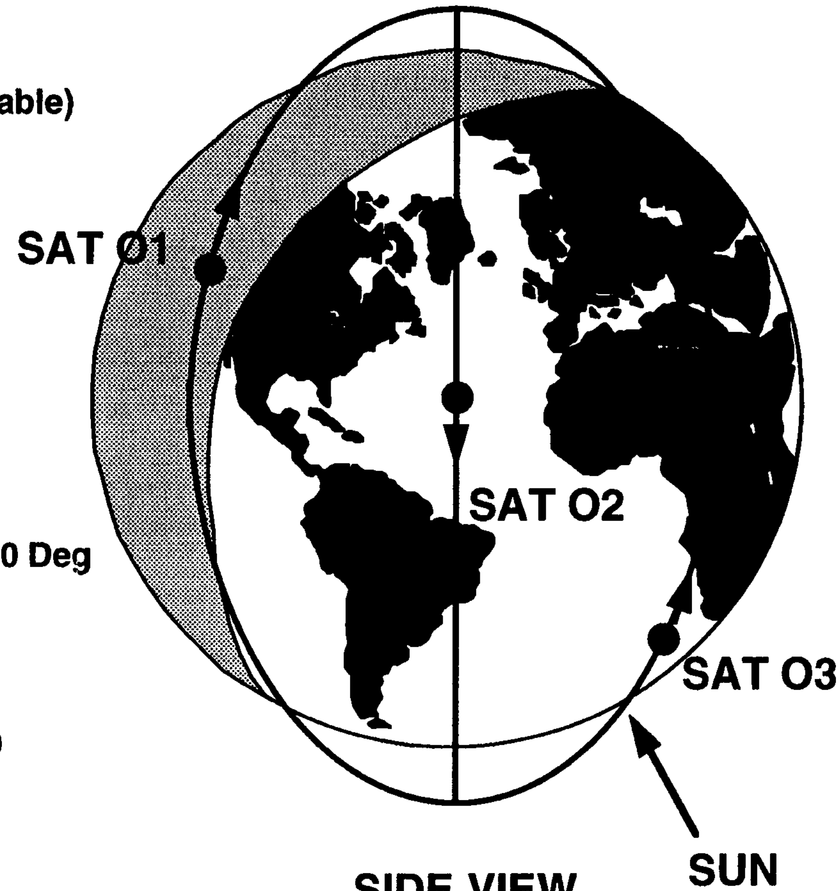
NPOESS CONSTELLATION (2 ASCENDING, 1 DESCENDING)

npoess

NOMINAL NODAL CROSSING TIMES (NCT):
NCT(O1)=0530 (Ascending) (Goal: User Selectable)
NCT(O2)=0930 (Descending)
2130 (Ascending)
NCT(O3)=1330 (Ascending)

TOP VIEW





SIDE VIEW

3/15/95

NODAL CROSSING TIME ANALYSIS INTRODUCTION

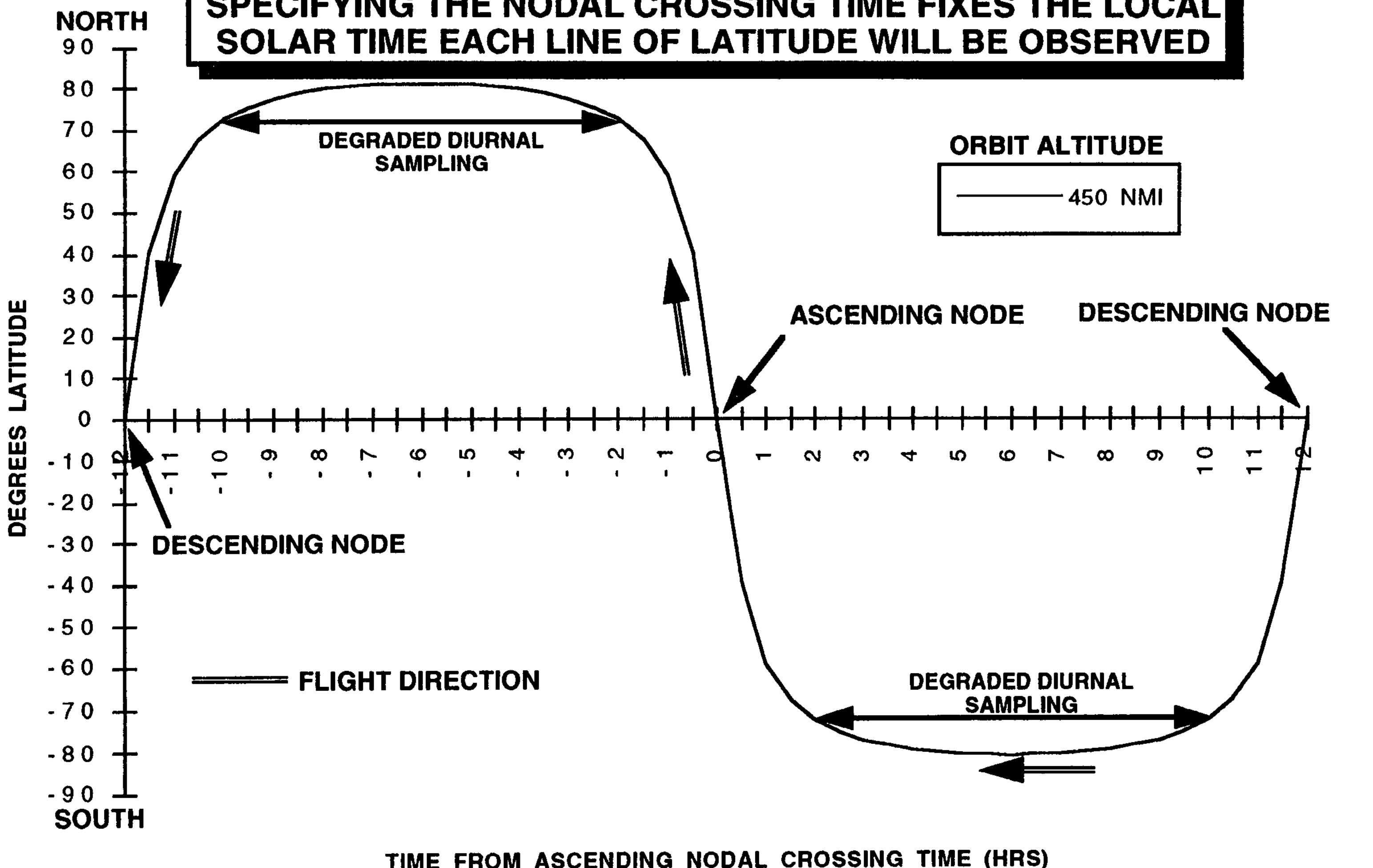
- NPOESS NODAL CROSSING TIMES CURRENTLY NOT SPECIFIED
- NODAL CROSSING TIME SELECTION AFFECTS NOT ONLY REFRESH, BUT ALSO LOCAL SOLAR TIME OF THE OBSERVATION
- ANOTHER DISCRIMINATOR FOR CONSTELLATION DESIGN
- SUN-SYNCHRONOUS ORBITS ALLOW EACH SATELLITE TO SEE SAME LATITUDE OVER SAME RANGE OF LOCAL SOLAR TIME
- RANGE OF LOCAL SOLAR TIME DEPENDS ON SENSOR'S SWATH WIDTH
- PLOTS OF LOCAL SOLAR TIME VERSUS LATITUDE
  - SHOW TEMPORAL COVERAGE FOR DIFFERENT COMBINATIONS OF NODAL CROSSING TIMES
  - SHOW TIMES OF DAY WHEN DATA WILL BE TAKEN FOR LATITUDES OF INTEREST
  - SHOW TIMES OF DAY WHEN DATA WILL NEVER BE AVAILABLE
- APPLIES PRIMARILY TO THOSE EDR'S ACQUIRED FROM OPTICAL INSTRUMENTS

CONVERGENCE EFFORT MODIFICATION

LOCAL SOLAR TIME VARIATION WITH LATITUDE

npoess

SPECIFYING THE NODAL CROSSING TIME FIXES THE LOCAL SOLAR TIME EACH LINE OF LATITUDE WILL BE OBSERVED

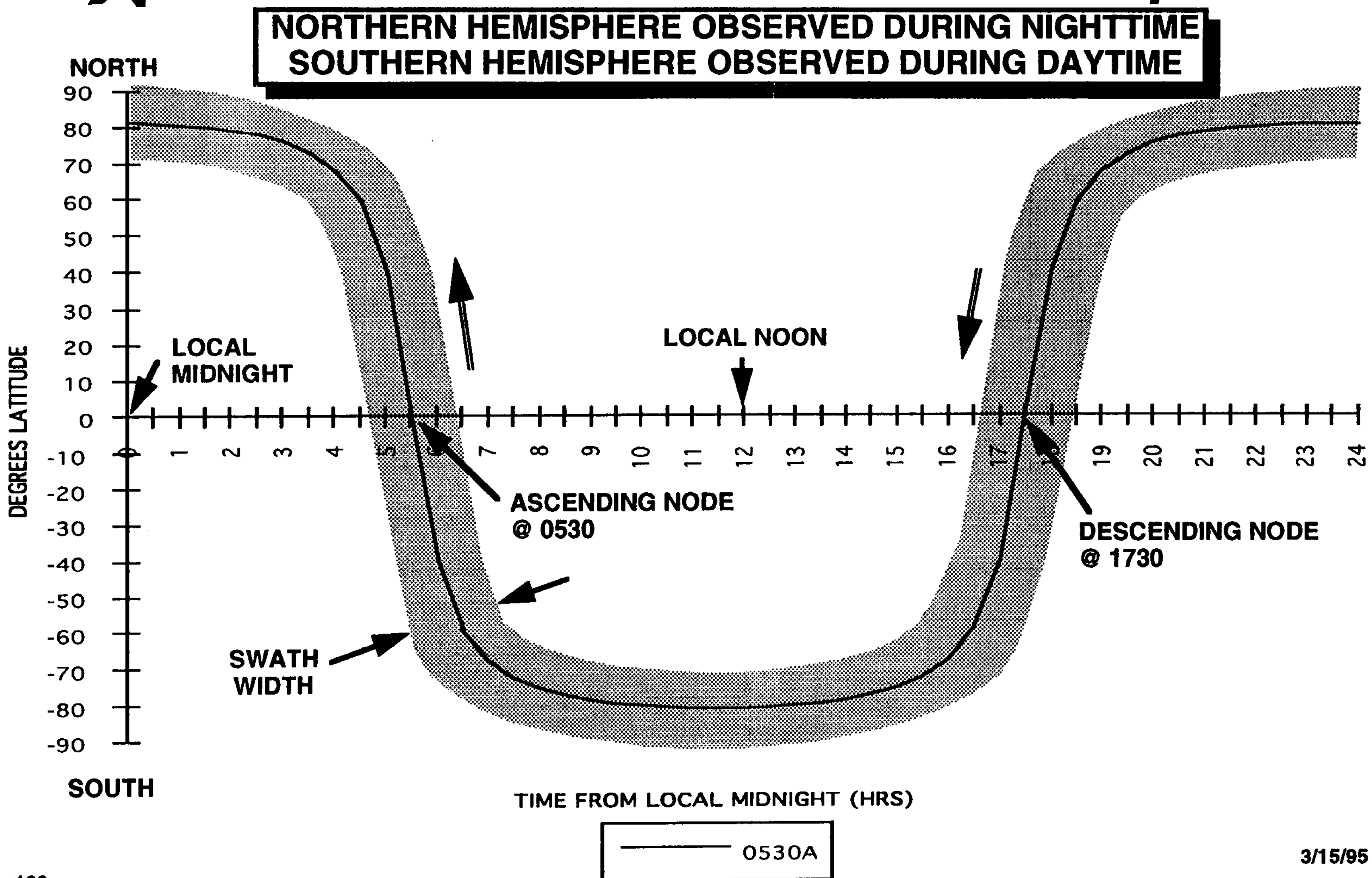


3/15/95

CONVERGENCE EFFORT MODIFICATION

LST VARIATION WITH LATITUDE FOR NCT OF 0530 ASCENDING

npoess

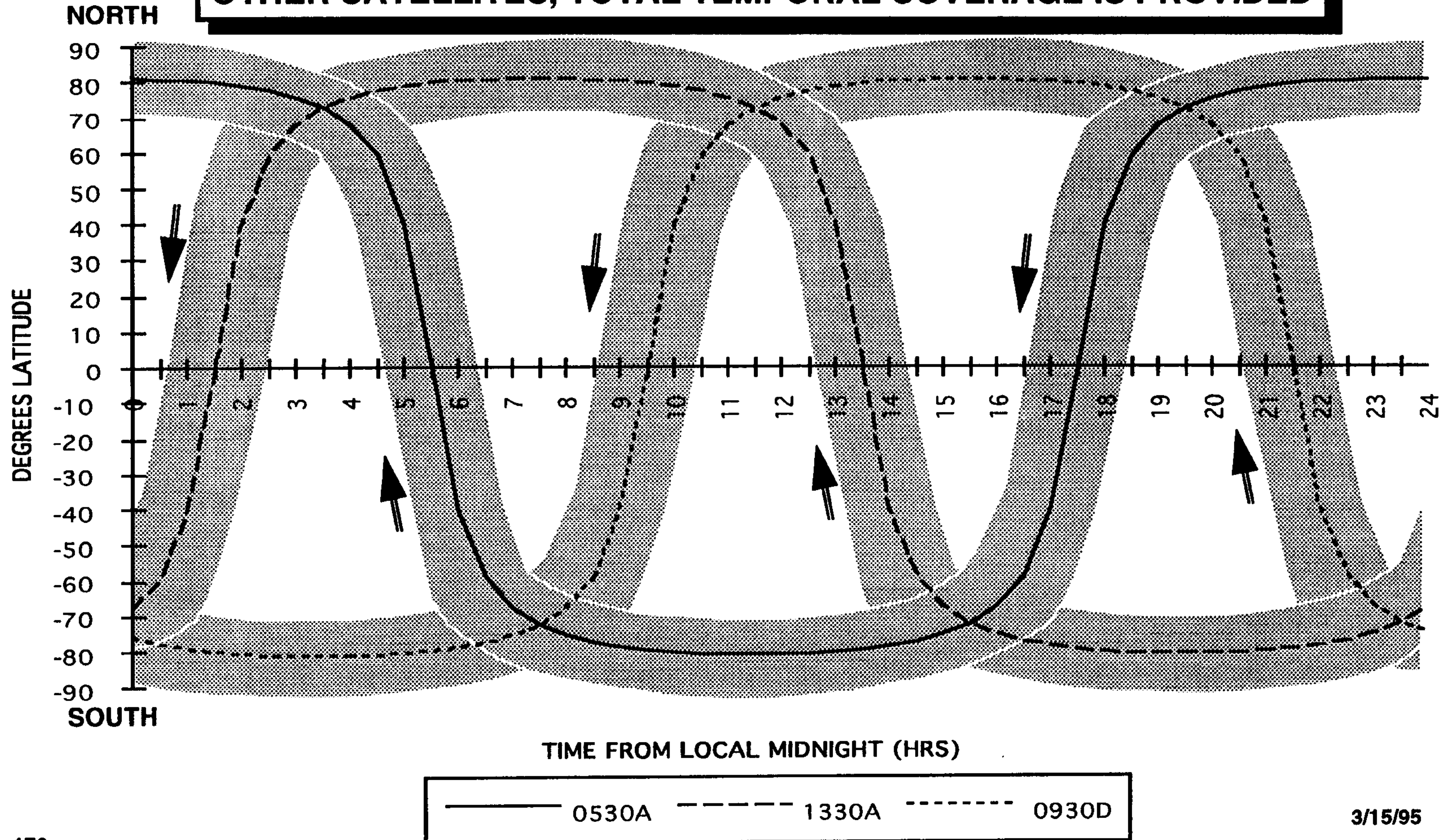


3/15/95

NCT IMPACT ON LST COVERAGE FOR 3-SATELLITE NOMINAL CASE

npoess

WHEN COMBINED WITH TEMPORAL COVERAGE PROVIDED BY OTHER SATELLITES, TOTAL TEMPORAL COVERAGE IS PROVIDED



3/15/95

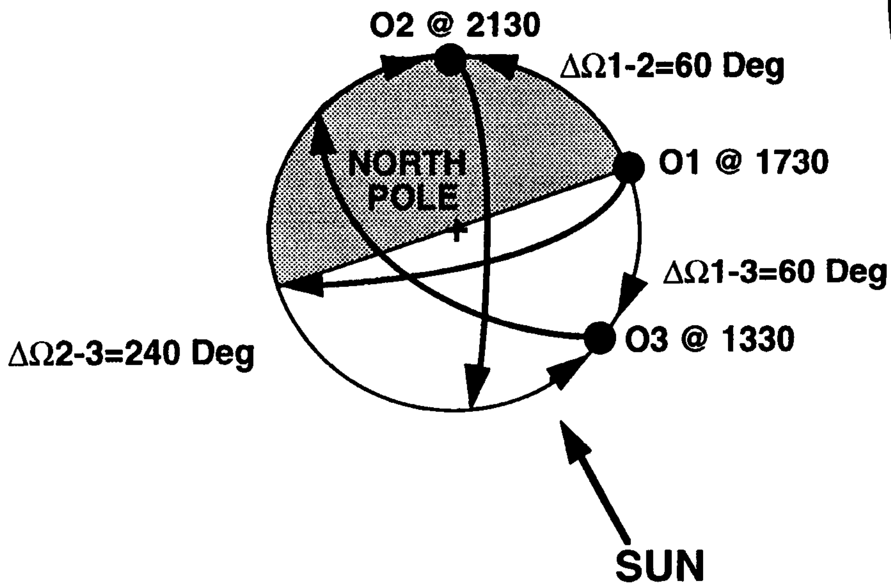
CONVERGENCE EFFORT MODIFICATION

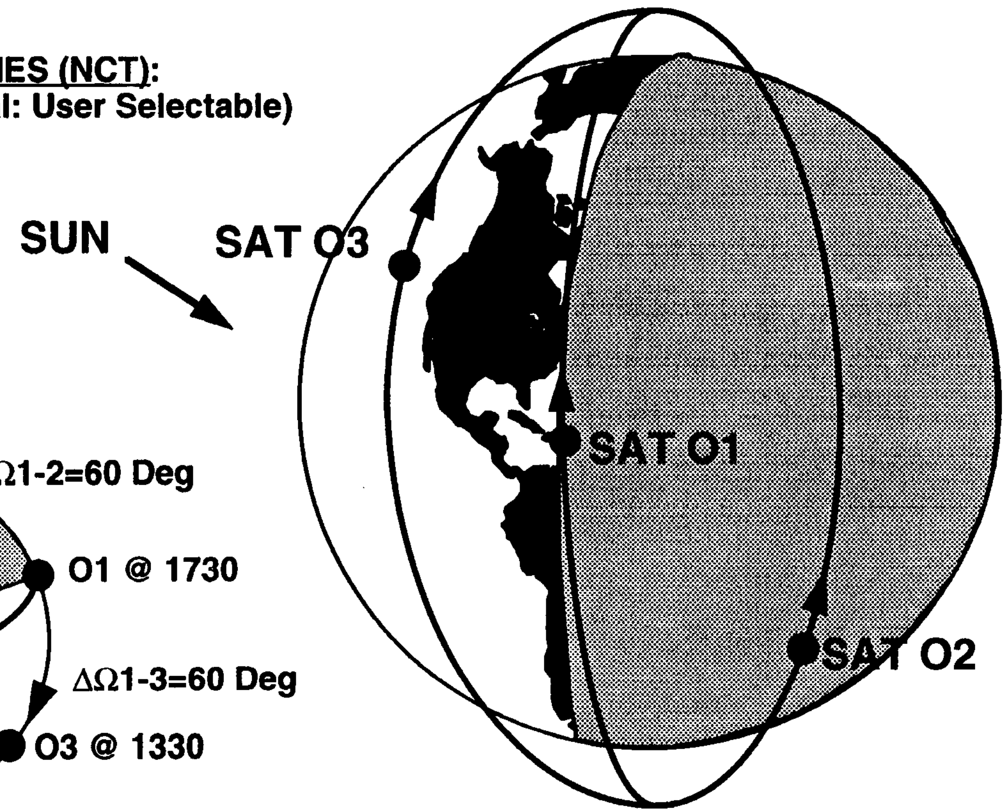
NPOESS CONSTELLATION (1 ASCENDING, 2 DESCENDING)

npoess

NOMINAL NODAL CROSSING TIMES (NCT):
NCT(O1)=0530 (Descending) (Goal: User Selectable)
NCT(O2)=0930 (Descending)
2130 (Ascending)
NCT(O3)=1330 (Ascending)

TOP VIEW





SIDE VIEW

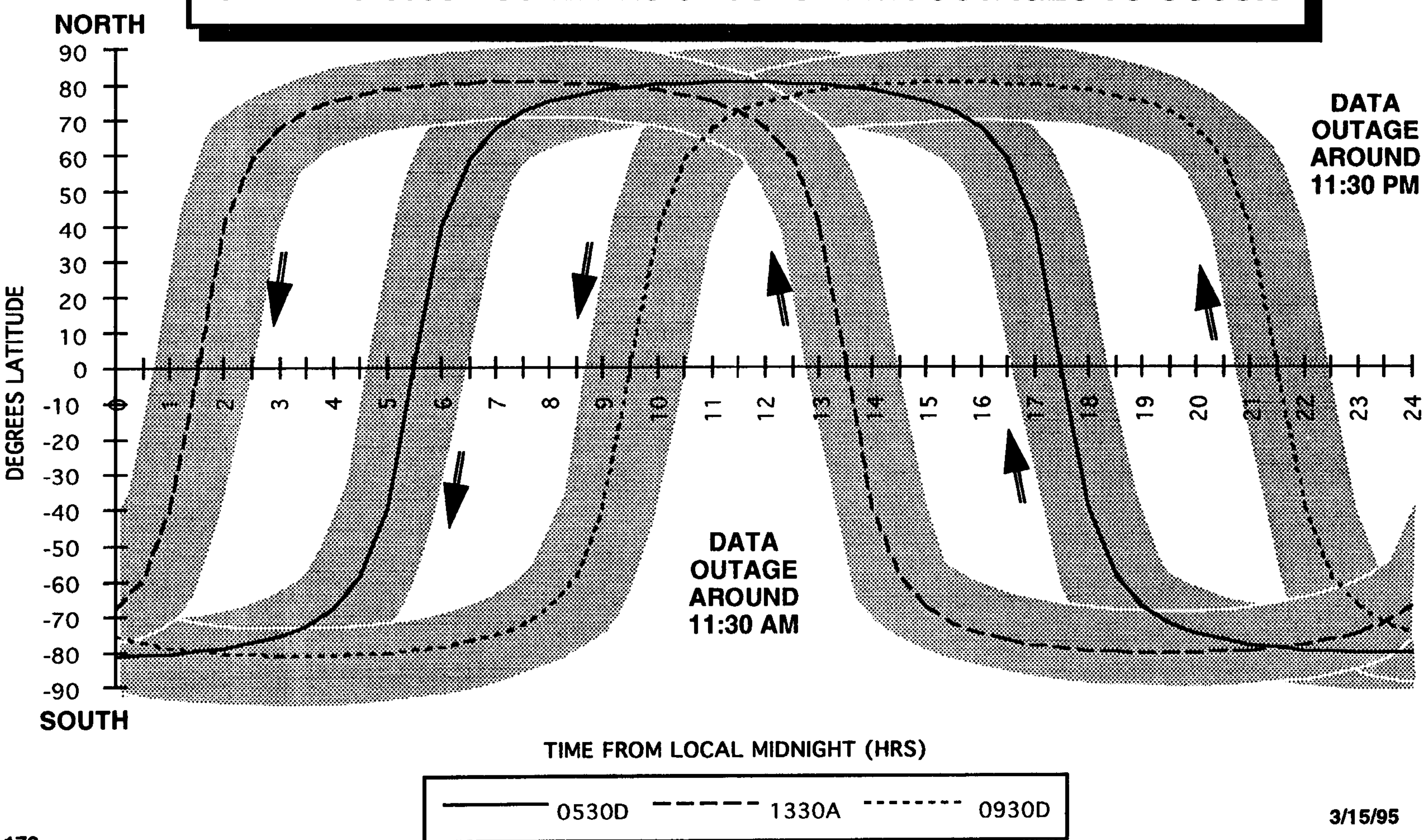
3/15/95

CONVERGENCE EFFORT MODIFICATION

NCT IMPACT ON LST COVERAGE FOR 3-SATELLITE CASE WITH 0530 DESCENDING

npoess

SHIFTING 0530 NCT 12 HRS CAUSES DATA OUTAGES TO OCCUR



3/15/95

0530 NCT CONSIDERATIONS

npoess

0530 ASCENDING

PROS:

- CAN PLACE SAR ON SUNSIDE FOR NORTH POLE COVERAGE
- MINIMIZES HOLES IN TEMPORAL COVERAGE
- TIMELINESS IMPACT - MORNING IN NORTHERN HEMISPHERE NEWEST DATA FOR HI-LAT DOWNLINK

CONS:

- NORTHERN HEMISPHERE VIEWED IN NIGHTTIME
- SPACECRAFT IMPACT - REQUIRES OPPOSITE DIRECTIONS OF FLIGHT FOR OTHER SPACECRAFT

0530 DESCENDING

PROS:

- IMPROVED REFRESH UNDER OPTIMUM CONDITIONS
- SUNSIDE OF SPACECRAFT ON LEFTSIDE FOR ALL NCT'S
- NORTHERN HEMISPHERE VIEWED IN DAYLIGHT

CONS:

- SAR WOULD HAVE TO BE ON DARKSIDE OF AT LEAST ONE SATELLITE FOR NORTH POLE COVERAGE
- CAUSES DATA OUTAGES TO OCCUR AROUND MIDNIGHT (NORTH) AND NOON (SOUTH)
- TIMELINESS IMPACT - MORNING IN NORTHERN HEMISPHERE OLDEST DATA FOR HI-LAT DOWNLINK

3/15/95

SUMMARY

npoess

CONSTELLATION BASELINE

- MAINTAINING THREE-SATELLITE CONSTELLATION WITH NOMINAL NCT'S AS CURRENT BASELINE

REFRESH SENSITIVITY

- FOUR-SATELLITE CONSTELLATION REQUIRED TO MEET 4 HR REFRESH

NODAL CROSSING TIME

- ADDING 0530 DESCENDING TO NODAL CROSSING TIME TRADE

SPACE SEGMENT

J. CLAPP

SPACECRAFT CONFIGURATION TRADES

EOS

NPOESS

npoess

CONVERGENCE EFFORT MODIFICATION

PAYLOAD MATRIX - BASELINE

npoess

SUITE	SENSOR		SATELLITE			
			L 1 Low	L 2 Baseline	L 3 High 1	L 4 High 2
IMAGER	OASIS		X	X	X	X
	MISS		X	X	X	X
	SeaWiFS					X
PROFILER	AIRS/ITS		X	X	X	X
	AMSU-A1		X	X	X	X
	AMSU-A2		X	X	X	X
	MHS		X	X	X	X
	IASI					
SPACE ENV	SES SENSORS			X	X	X
CLIMATE	CERES					X
	SBUV / TOMS			X	X	X
	GAS ANALYZER					X
OTHER	TDRSS					
	STORE & FORWARD					
	SURF DATA COLL (ARGOS)			X	X	X
	SEARCH & RESCUE			X	X	X
	MSTRS		X	X	X	X
	SAR				X	
	LIDAR					X
	ALTIMETER				X	
	LAUNCH VEHICLE		DELTA II	DELTA II	DELTA II	DELTA II
	NODAL CROSSING TIME		ALL	ALL	ALL	ALL

3/15/95

CONVERGENCE EFFORT MODIFICATION

NPOESS BASELINE SPACECRAFT DEPLOYED CONFIGURATION

npoess

NPOESS BASELINE SPACECRAFT STOWED CONFIGURATION

CONVERGENCE EFFORT MODIFICATION

SENSOR PARAMETERS - BASELINE (SHT 1 OF 2)

npoess

INSTRUMENT	V	S	N	Volume	Footprint	Wt	Power	Attitude	Data Rate	FOV	Notes
SPECS	MM	MM	MM	Cubic m	Sq meters	Kg	Watts	Know(deg)	Kbps	deg	* Wt incl conting
						*					& antennas
0	0	0	0	0	0	0	0	0	0	0	0
OASIS/8	1170	890	660	0.6873	1.0413	89	230	0.03	4500	±55.7 xtrk	w/o sunshade
OASIS-Elect'r'x	760	410	200	0.0623	0	32	0	0	0	0	0
OASIS-Ps	300	200	200	0.012	0	11	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
MISS	510	510	510	0.5327	0.2601	100	175	0.05	37.3	±70az,+56el	& 2 M Dish (.4 CuM)
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
AMSU-A1	655	299	592	0.1159	0.19585	53	70	0.1	2.1	+49.5,-90 xtrk	0
AMSU-A2	546	649	697	0.247	0.35435	48	40	0.1	1.1	+49.5,-90 xtrk	0
MHS-Sen & Electr	774	990	560	0.4291	0.76626	66	85	0.1	4.2	+49.5,-90 xtrk	
0	0	0	0	0	0	0	0	0	0	0	0
AIRS	1397	775	762	0.825	1.08268	133	224	0.25	1420	±49.5 xtrk	0
0	0	0	0	0	0	0	0	0	0	0	0
SBUV-Sensor	359	311	356	0.0397	0.11165	26	20	0	1	12 x 12 nadir	0
SBUV-Elect	222	311	330	0.0228	0.06904	15	0	0	0	0	
TOMS	500	500	610	0.1525	0.25	30	25	0.05	0.5	±54 xtrk	0

3/15/95

CONVERGENCE EFFORT MODIFICATION

SENSOR PARAMETERS - BASELINE
(SHT 2 OF 2)

npoess

INSTRUMENT	V	S	N	Volume	Footprint	Wt	Power	Attitude	Data Rate	FOV	Notes
SPECS	MM	MM	MM	Cubic m	Sq meters	Kg	Watts	Know(deg)	Kbps	deg	* Wt incl conting
						*					& antennas
SESS:	0	0	0	0	0	0	0	0	0	0	0
AVM	164	141	52	0.0012	0.02312	10	1	N/A	0.24	in-situ	with Sensor Boom *
ABIS-UV	250	560	330	0.0462	0.14	8	7	0.1	3	±50 xtrk	0
RPA	230	250	250	0.0144	0.0575	11	11	0.1	2	±60,vel vect	w/o grd plane *
GPS-Rcvr	250	225	120	0.0068	0.05625	4	6	0.3	2	omni	w/o antennas *
GPS-Process	170	100	70	0.0012	0.017	3	6	0	0	0	0
HEPS	203	140	312	0.0089	0.02842	6	6	N/A	0.27	omni	TBD (was DOS)
NADIS	467	300	330	0.0462	0.1401	8	7	0.1	1	earth limb	0
MEPS	222	146	152	0.0049	0.03241	4	5	0.1	1.2	8x128,zenith	0
0	0	0	0	0	0	0	0	0	0	0	0
S&R-RPU(2)	195	365	280	0.0199	0.07118	31.2	22.8	0	0	0	0
S&R-SPU	195	310	280	0.0169	0.06045	14.4	6	0	0	0	0
S&R-Rcvr	458	458	152	0.0319	0.20976	15.2	21	0	0	omni	w/o antennas *
S&R-Xmit	350	370	115	0.0149	0.1295	15.2	39	0	0	omni	w/o antennas *
ARGOS-RPU	195	365	280	0.0199	0.07118	16.8	25.2	0	2.56	omni	w/o antennas *
ARGOS-SPU(2)	195	310	280	0.0339	0.1209	31.2	7.2	0	0	0	0
ARGOS-DCSR	195	310	280	0.0169	0.06045	18	30	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
MSTRS-RCVR	76	127	102	0.001	0.00965	0	0	0	0	0	0
MSTRS-XMT/PROC	127	178	127	0.0029	0.02261	5	20	N/A	0	0	0
MSTRS-SENSOR	152	152	152	0.0035	0.0231	0	0	0	0	0	0
Totals				3.418	5.405	804	1089		5978.5		3/15/95

CONVERGENCE EFFORT MODIFICATION

NPOESS HIGH 1 SPACECRAFT DEPLOYED CONFIGURATION

npoess

CONVERGENCE EFFORT MODIFICATION

SENSOR PARAMETERS - HIGH 1
(SHT 1 OF 2)

npoess

INSTRUMENT SPECS	V MM	S MM	N MM	Volume Cubic m	Footprint Sq meters	Wt Kg *	Power Watts	Attitude Know(deg)	Data Rate Kbps	FOV deg	Notes * Wt incl conting & antennas
0	0	0	0	0	0	0	0	0	0	0	0
OASIS/8	1170	890	660	0.6873	1.0413	89	230	0.03	4500	±55.7 xtrk	w/o sunshade
OASIS-Elect'r'x	760	410	200	0.0623	0	32	0	0	0	0	0
OASIS-Ps	300	200	200	0.012	0	11	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
SAR Antenna	10058	1341	125	1.686	13.4878	198	150	0.03	0	36 deg el, sun sid	0
SAR Electronics,PS	382	382	382	0.0557	0.14592	23	150	0	14000	0	0
MISS	510	510	510	0.5327	0.2601	100	175	0.05	37.3	±70az,+56el	& 2 M Dish (.4 CuM)
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
ALT	500	500	200	0.17	0.25	53	106	0.03	12	Coherent	& 1 M Dish (.12CuM)
AMSU-A1	655	299	592	0.1159	0.19585	53	70	0.1	2.1	+49.5,-90 xtrk	0
AMSU-A2	546	649	697	0.247	0.35435	48	40	0.1	1.1	+49.5,-90 xtrk	0
MHS-Sen & Electr	774	990	560	0.4291	0.76626	66	85	0.1	4.2	+49.5,-90 xtrk	
0	0	0	0	0	0	0	0	0	0	0	0
AIRS	1397	775	762	0.825	1.08268	133	224	0.25	1420	±49.5 xtrk	0
0	0	0	0	0	0	0	0	0	0	0	0
SBUV-Sensor	359	311	356	0.0397	0.11165	26	20	0	1	12 x 12 nadir	0
SBUV-Elect	222	311	330	0.0228	0.06904	15	0	0	0	0	
TOMS	500	500	610	0.1525	0.25	30	25	0.05	0.5	±54 xtrk	0

3/15/95

CONVERGENCE EFFORT MODIFICATION

SENSOR PARAMETERS - HIGH1 (SHT 2 OF 2)

npoess

INSTRUMENT	V	S	N	Volume	Footprint	Wt	Power	Attitude	Data Rate	FOV	Notes
SPECS	MM	MM	MM	Cubic m	Sq meters	Kg	Watts	Know(deg)	Kbps	deg	* Wt incl conting
						*					& antennas
SESS:	0	0	0	0	0	0	0	0	0	0	0
AVM	164	141	52	0.0012	0.02312	10	1	N/A	0.24	in-situ	with Sensor Boom *
ABIS-UV	250	560	330	0.0462	0.14	8	7	0.1	3	±50 xtrk	0
RPA	230	250	250	0.0144	0.0575	11	11	0.1	2	±60,vel vect	w/o grd plane *
GPS-Rcvr	250	225	120	0.0068	0.05625	4	6	0.3	2	omni	w/o antennas *
GPS-Process	170	100	70	0.0012	0.017	3	6	0	0	0	0
HEPS	203	140	312	0.0089	0.02842	6	6	N/A	0.27	omni	TBD (was DOS)
NADIS	467	300	330	0.0462	0.1401	8	7	0.1	1	earth limb	0
MEPS	222	146	152	0.0049	0.03241	4	5	0.1	1.2	8x128,zenith	0
0	0	0	0	0	0	0	0	0	0	0	0
S&R-RPU(2)	195	365	280	0.0199	0.07118	31.2	22.8	0	0	0	0
S&R-SPU	195	310	280	0.0169	0.06045	14.4	6	0	0	0	0
S&R-Rcvr	458	458	152	0.0319	0.20976	15.2	21	0	0	omni	w/o antennas *
S&R-Xmit	350	370	115	0.0149	0.1295	15.2	39	0	0	omni	w/o antennas *
ARGOS-RPU	195	365	280	0.0199	0.07118	16.8	25.2	0	2.56	omni	w/o antennas *
ARGOS-SPU(2)	195	310	280	0.0339	0.1209	31.2	7.2	0	0	0	0
ARGOS-DCSR	195	310	280	0.0169	0.06045	18	30	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
MSTRS-RCVR	76	127	102	0.001	0.00965	0	0	0	0	0	0
MSTRS-XMT/PROC	127	178	127	0.0029	0.02261	5	20	N/A	0	0	0
MSTRS-SENSOR	152	152	152	0.0035	0.0231	0	0	0	0	0	0
Totals				5.329	19.289	1078	1495		19990		

9/15/95

CONVERGENCE EFFORT MODIFICATION

SENSOR PARAMETERS - HIGH 2
(SHT 1 OF 2)

npoess

INSTRUMENT SPECS	V MM	S MM	N MM	Volume Cubic m	Footprint Sq meters	Wt Kg *	Power Watts	Attitude Know(deg)	Data Rate Kbps	FOV deg	Notes * Wt incl conting & antennas
0	0	0	0	0	0	0	0	0	0	0	0
OASIS/8	1170	890	660	0.6873	1.0413	89	230	0.03	4500	±55.7 xtrk	w/o sunshade
OASIS-Elect'r'x	760	410	200	0.0623	0	32	0	0	0	0	0
OASIS-Ps	300	200	200	0.012	0	11	0	0	0	0	0
SeaWIFS	510	510	510	0.1327	0.2601	45	40	0	1000	±58 deg, Sol Cal	Pwr & Data - TBD
MOPITT	1062	810	550	0.4731	0.86022	150	210	0.14	5	±31 xtrk	0
0	0	0	0	0	0	0	0	0	0	0	0
LIDAR	940	813	711	0.5434	0.76422	85	80	0	1.8	0	0
MISS	510	510	510	0.5327	0.2601	100	175	0.05	37.3	±70az,+56el	& 2 M Dish (.4 CuM)
0	0	0	0	0	0	0	0	0	0	0	0
CERES	600	600	576	0.2074	0.36	45	50	0.05	10	±78 cone, +Z	0
0	0	0	0	0	0	0	0	0	0	0	0
AMSU-A1	655	299	592	0.1159	0.19585	53	70	0.1	2.1	+49.5,-90 xtrk	0
AMSU-A2	546	649	697	0.247	0.35435	48	40	0.1	1.1	+49.5,-90 xtrk	0
MHS-Sen & Electr	774	990	560	0.4291	0.76626	66	85	0.1	4.2	+49.5,-90 xtrk	
0	0	0	0	0	0	0	0	0	0	0	0
AIRS	1397	775	762	0.825	1.08268	133	224	0.25	1420	±49.5 xtrk	0
0	0	0	0	0	0	0	0	0	0	0	0
SBUV-Sensor	359	311	356	0.0397	0.11165	26	20	0	1	12 x 12 nadir	0
SBUV-Elect	222	311	330	0.0228	0.06904	15	0	0	0	0	
TOMS	500	500	610	0.1525	0.25	30	25	0.05	0.5	±54 xtrk	0

3/15/95

CONVERGENCE EFFORT MODIFICATION

NPOESS HIGH 2 SPACECRAFT DEPLOYED CONFIGURATION

CONVERGENCE EFFORT MODIFICATION

SENSOR PARAMETERS - HIGH 2
(SHT 2 OF 2)

npoess

INSTRUMENT	V	S	N	Volume	Footprint	Wt	Power	Attitude	Data Rate	FOV	Notes
SPECS	MM	MM	MM	Cubic m	Sq meters	Kg	Watts	Know(deg)	Kbps	deg	* Wt incl conting
						*					& antennas
SESS:	0	0	0	0	0	0	0	0	0	0	0
AVM	164	141	52	0.0012	0.02312	10	1	N/A	0.24	in-situ	with Sensor Boom *
ABIS-UV	250	560	330	0.0462	0.14	8	7	0.1	3	±50 xtrk	0
RPA	230	250	250	0.0144	0.0575	11	11	0.1	2	±60,vel vect	w/o grd plane *
GPS-Rcvr	250	225	120	0.0068	0.05625	4	6	0.3	2	omni	w/o antennas *
GPS-Process	170	100	70	0.0012	0.017	3	6	0	0	0	0
HEPS	203	140	312	0.0089	0.02842	6	6	N/A	0.27	omni	TBD (was DOS)
NADIS	467	300	330	0.0462	0.1401	8	7	0.1	1	earth limb	0
MEPS	222	146	152	0.0049	0.03241	4	5	0.1	1.2	8x128,zenith	0
0	0	0	0	0	0	0	0	0	0	0	0
S&R-RPU(2)	195	365	280	0.0199	0.07118	31.2	22.8	0	0	0	0
S&R-SPU	195	310	280	0.0169	0.06045	14.4	6	0	0	0	0
S&R-Rcvr	458	458	152	0.0319	0.20976	15.2	21	0	0	omni	w/o antennas *
S&R-Xmit	350	370	115	0.0149	0.1295	15.2	39	0	0	omni	w/o antennas *
ARGOS-RPU	195	365	280	0.0199	0.07118	16.8	25.2	0	2.56	omni	w/o antennas *
ARGOS-SPU(2)	195	310	280	0.0339	0.1209	31.2	7.2	0	0	0	0
ARGOS-DCSR	195	310	280	0.0169	0.06045	18	30	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
MSTRS-RCVR	76	127	102	0.001	0.00965	0	0	0	0	0	0
MSTRS-XMT/PROC	127	178	127	0.0029	0.02261	5	20	N/A	0	0	0
MSTRS-SENSOR	152	152	152	0.0035	0.0231	0	0	0	0	0	0
Totals				4.774	7.649	1129	1469		6995.3		

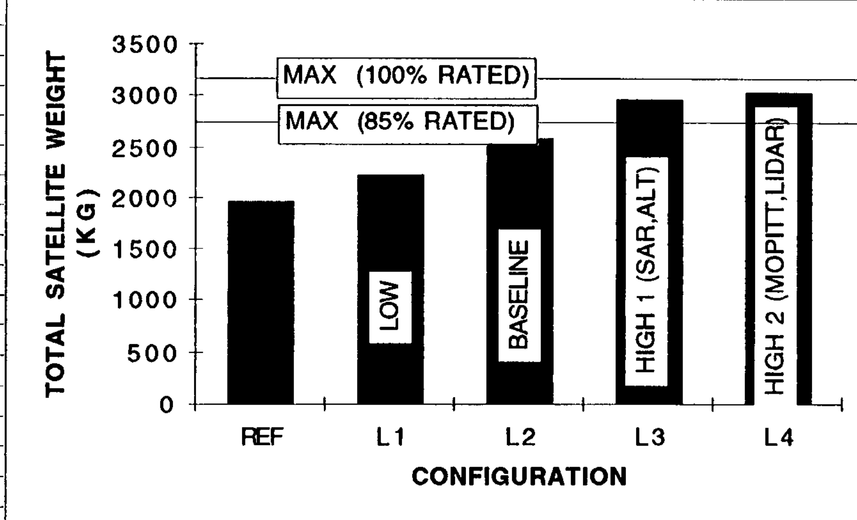
3/15/95

CONVERGENCE EFFORT MODIFICATION

PAYLOAD WEIGHT COMPARISON

npoess

SUBSYSTEM	WEIGHT(Kg)
	FSAT-AI
	Wings-Gr/Ep
STRUCTURES	667
ELECTRICAL	461
ATTITUDE DETERM & CTR	107
CMD, TLM, DH	194
PROPULSION	52
THERMAL + Surviv	81
TDRSS	
TOTAL DRY WEIGHT	1562
PROPELLANT (DMSP B/L)	47
TOTAL S/C BUS - BASIC	1609



SENSOR COMPLEMENT	SENSOR TOTAL	GROWTH	S/C DELTA	TOTAL SATELLITE		LAUNCH CAPABILITY 833KM, SUN SYNCH, 85%	
	Kg	Kg	Kg (38%)	(KG)	(LBS)	DELTA 7920	PERCENT
		NONE				KG/LBS	OF MAX
						2722(6K#)	
CONFIGURATION							
REF	350	0	0	1959	4320	2722	72
L 1	537	0	71	2217	4889	2722	81
L 2	804	0	173	2586	5701	2722	95
L 3	1078	0	277	2964	6535	2723	109
L 4	1129	0	296	3034	6690	2722	111
L2 = NPOESS BASELINE						(100% = 3202 Kg)	

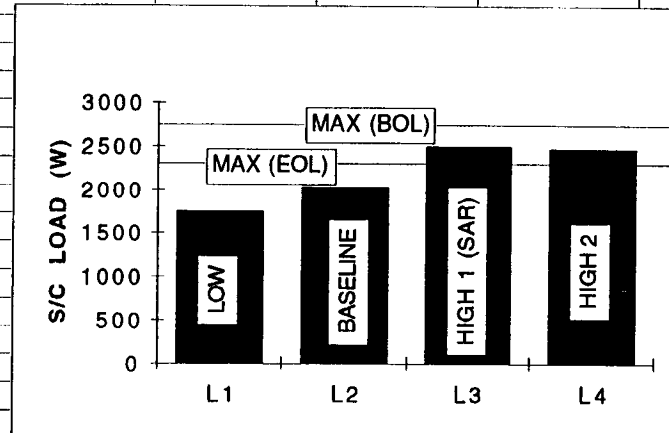
3/15/95

CONVERGENCE EFFORT MODIFICATION

PAYLOAD POWER COMPARISON

npoess

SUBSYSTEM	POWER (W)
STRUCTURES	
ELECTRICAL	56
ATTITUDE DETERM & CTR	213
CMD, TLM, DH	370
PROPULSION	3
THERMAL	195
SUB-TOTAL	837
SURVIVABILITY	18
TOTAL S/C BUS	855



SENSOR COMPLEMENT	SENSOR TOTAL W	GROWTH (W) B/L +25% CONV +0%	S/C DELTA W (15%)	TOTAL SATELLITE LOAD W	Solar Array (BOL) W	SA WT-Diff KG (44w/kg)	BATTERY* A-H Total DOD<35%	BATTERY W Diff (KG) 1=50 KG*
REF (DMSP)	533	133	0	1521	3727	0	101	0 *
CONFIGURATION								
L1	844	0	47	1746	4268	12.3	116	0 *
L2	1089	0	83	2027	4947	27.7	135	0 *
L3	1495	0	144	2494	6072	53.3	166	0 *
L4	1469	0	140	2464	6000	51.7	164	0 *
L3 - SAR PWR HIGH	300 W Continuous or ~1 Kw @ 0.33 d.							
							* ADD BATTERY IF A-H	
L4 - MOPITT, LIDAR, SeaWIFS, CERES								

3/15/95

SUMMARY / ISSUES

- BASELINE CONFIGURATION CAN BE ACCOMMODATED
- BASELINE NEAR MAXIMUM CAPABILITY FOR WEIGHT, POWER, AND SIZE
- SENSOR MATRIX/PARAMETERS - UNSETTLED
- SURVIVABILITY - TBR
- MLV - DELTA II BASELINE
  - DELTA: HIGH VERSIONS REQUIRE 5 FT EXTENDED SHROUD (APPROVED FOR EOS PROGRAM)
- HIGH END SYSTEM - REQUIREMENTS STRESS WEIGHT, SIZE, AND POWER LIMITS FOR THIS PHASE OF PROGRAM (TBR)

SENSORS

P. CALLARY
M. DAVIS

SENSOR OVERVIEW

• OASIS	P. CALLARY
• IR SOUNDER	P. CALLARY
• SAR	P. CALLARY
• MISS	M. DAVIS
• SESS	M. DAVIS

OASIS SENSOR PRESENTATION OVERVIEW

- KEY ACTIVITIES
- HORIZONTAL SPATIAL RESOLUTION IMPACTS
- CALIBRATION CONSIDERATION
- OTHER OASIS ISSUES

KEY OASIS ACTIVITIES

- IMPACTS OF 12 JAN SPECIFICATION CHANGE
  - HORIZONTAL SPATIAL RESOLUTION = 0.65 AT SCAN EDGE
    - » RECEIVED 3/3 UPDATE FURTHER CHANGING THIS DEFINITION
  - NON-EXPLICIT EDR CALIBRATION REQUIREMENTS
- APPROACH TO HORIZONTAL SPATIAL RESOLUTION CHANGE
  - FIXED PERFORMANCE - DESCRIBE H/W IMPACT
  - FIX H/W I/F CHARACTERISTICS - DESCRIBE PERFORMANCE IMPACT
- CALIBRATION APPROACH
  - DEVELOP DERIVED REQUIREMENTS FOR CALIBRATION BASED ON EDR NEEDS
  - DESCRIBE OASIS IMPACTS
    - » INTERNAL CALIBRATOR

Horizontal Spatial Resolution Requirement Change Synopsis

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

Performance Estimates Summary - High Resolution Requirement

PAGE 199 IS EXEMPT FROM RELEASE AND IS REPLACED WITH THIS PAGE.

Design Changes Required to Accommodate 0.65 km Footprint are Summarized

SANTA BARBARA RESEARCH CENTER
a subsidiary

Design Alternatives were Evaluated to Meet SNR/NEΔTSpecification for 0.65 km Footprint @ End-of-Scan

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

Performance Estimates are Defined for 0.65 km Footprint at End-of-Scan

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

Design Studies Should Refine Understanding of 0.65 km Option

SBRC INTERNAL CALIBRATION HERITAGE

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

MODIS HAS SOPHISTICATED INTERNAL CALIBRATION FUNCTIONS

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

TWO DESIGN APPROACHES ARE AVAILABLE FOR AN OASIS INTERNAL CALIBRATOR

BASELINE OASIS RADIOMETRIC CALIBRATION CAPABILITY

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

MINIMAL OUTLINE CHANGES WILL RESULT WITH SOLAR DIFFUSER DELETION

ONGOING SENSOR ISSUES

HUGHES
SANTA BARBARA RESEARCH CENTER
a subsidiary

- NEW DEFINITION OF HORIZONTAL SPATIAL RESOLUTION
  - DATA RATE IMPACTS ARE SEVERE
- EUMETSAT INTERFACE CONCERN
- SURVIVABILITY

OASIS SENSOR SUMMARY

npoess

- HORIZONTAL SPATIAL RESOLUTION = 0.65 km AT 55.6°
  - CAN BE ACHIEVED
  - OASIS SIZE IMPACT ON S/C LAYOUT IS TBD (BUT IS A REAL CONCERN)
  - LCC COST IMPACT HAS BEEN ESTIMATED

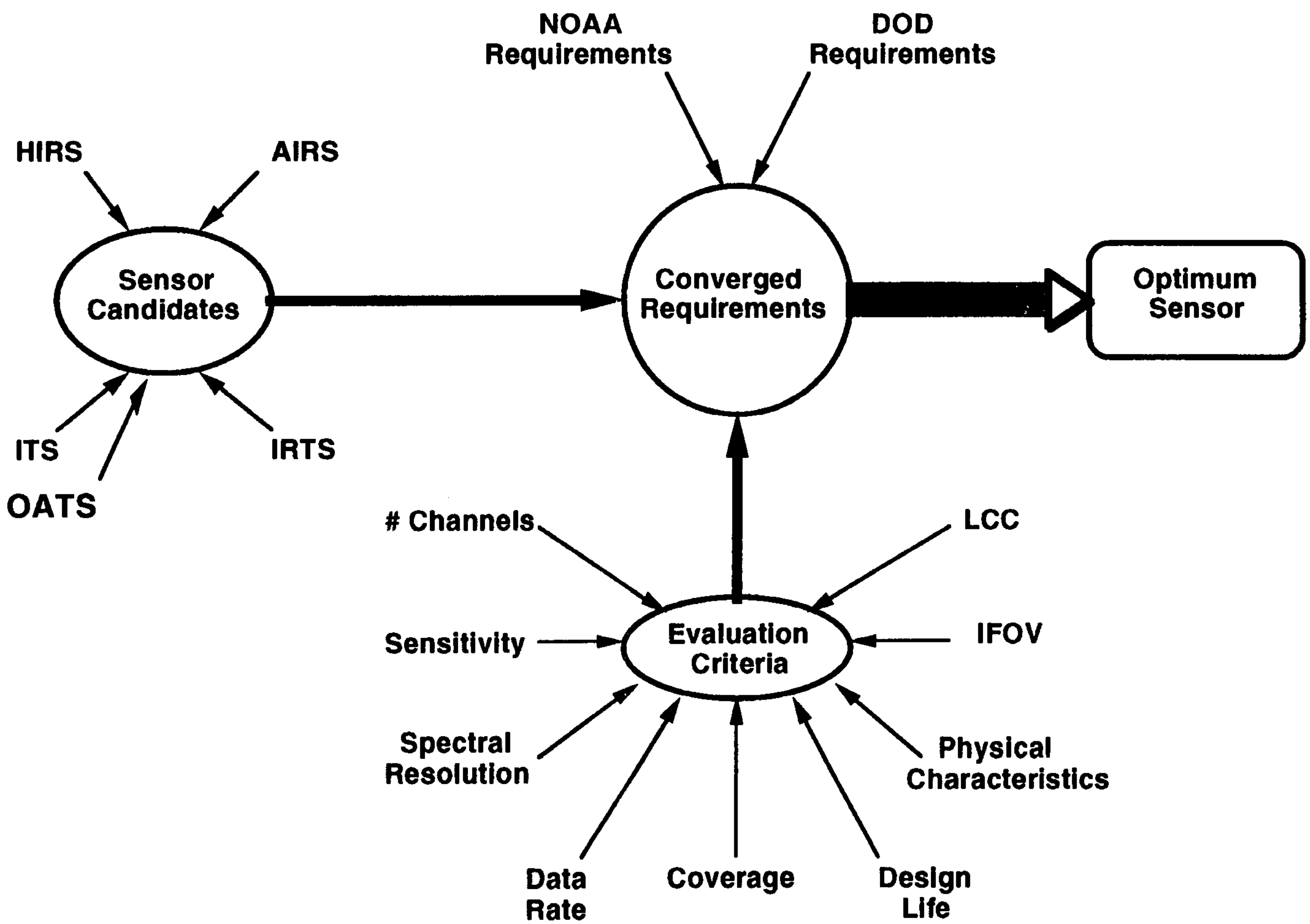
- SOLAR CALIBRATOR WILL BE ELIMINATATED FROM OASIS BASELINE
  - NO REQUIREMENT TO SUPPORT SOLAR CALIBRATOR
  - INTERNAL ON-BOARD STABILITY MONITOR (CALIBRATOR)
    - » REFERENCES CHANGES FROM PRE-LAUNCH CALIBRATION
    - » USED IN CONJUNCTION WITH GROUND TRUTH

- RI#20 RESPONSE IS A CHANGE AND IS QUITE ALARMING
  - RESPONSE IS INCONSISTENT WITH ALL PRIOR DEFINITIONS OF HORIZONTAL SPATIAL RESOLUTION
  - SEVERE IMPACT ON SENSOR DESIGN AND DATA RATE

CONVERGENCE EFFORT MODIFICATION

IR SOUNDER TRADE PROCESS

npoess



3/15/95

IR SOUNDER TRADE STATUS

- RFIs HAVE BEEN ISSUED WITH RESPONSES DUE ON 28 MARCH
  - AIRS (LIRIS)
  - OPERATIONAL ATMOSPHERIC TEMPERTURE SOUNDER - OATS (SBRC)
- FUNDAMENTAL TRADE BOILS DOWN TO *AIRS* vs a *MICHELSON INTERFEROMETER* (SBRC OATS SENSOR)
- INFORMATION FROM THE RFIs WILL BE USED TO DETERMINE THE SOUNDER APPROACH BASELINED BY LMSC

Motivation for Interferometer Development

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

- Interferometer Thermal Sounder (ITS) was conceived as Next-Generation Operational Sounder for POES/ Eumetsat Missions
- ITS was designed to provide improved sounding capability in HIRS sized package
- AIRS experiment was designed for NASA's EOS mission - Overkill for operational mission
- [redacted]

ITS Design Modified to Give AIRS Performance - OATS

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

AIRS - OATS Comparison

CHARACTERISTIC	AIRS
Spectral Resolving power	1200
Spatial Resolution	15 km
Number of Detectors	4456
Focal Plane	Very Complex
Number of spectral samples	2378 ($\Delta\lambda/2$ spacing)
Cooling Required	Mechanical Refrigerator
Mechanical Complexity	Mech. Refrigerator is reliability lien
Optical Complexity	High
Electronic Complexity	Moderate
Data Rate	1.3 Mbps
Mass	~ 133 kg
Size	140 x 77.5 x 76.2 cm
Power	~ 223 watts

OATS Design Characteristics

HUGHES

SANTA BARBARA RESEARCH CENTER
a subsidiary

IR SOUNDER TRADE - SUMMARY

- RFI RESPONSES IN WORK AT SBRC AND LIRIS

- KEY ISSUES
  - 7 YEAR RELIABILITY
  - RISK
  - SURVIVABILITY

- COST TRADE IS WRAPPED AROUND THE KEY ISSUES
  - AIRS RECURRING COSTS (PLUS ANY MODIFICATION NRE)
  - OATS NRE + RECURRING COSTS

CONVERGENCE EFFORT MODIFICATION

Synthetic Aperture Radar (SAR) CONSIDERATIONS FOR SEA-ICE EDR

npoess

- DETAILED TIM HELD WITH IPO ON 23 ~~APRIL~~ FEB
  - RANGE OF SAR SOLUTIONS
  - LMSC SAR EXPERTISE
  - BREAKTHROUGH HARWARE ID EFFORTS
    - » LOWER COST AND WEIGHT
- SUMMARY OF TIM PRESENTED HERE
- FUTURE COST vs UTILITY STUDIES WILL DICTATE FINAL DESIGN CAPABILITY

CONVERGENCE EFFORT MODIFICATION

KEY SAR CHARACTERISTICS

npoess

CAPABILITY

MEETS MOST SEA-ICE MINIMUMS
- ICE THICKNESS TBD SET TO ≤ 2 M
  - VERICAL SAMPLE TBD SET ≤ ~0.5 m
- 1st YEAR ICE IS A DESIGN DRIVER
- ICE-CONCENTRATION DRIVES DATA RATE

CAN MEET MOST GOALS
- ICE THICKNESS AN EXCEPTION
  - VERTICAL SAMPLE = 0.2 m IS AN ISSUE
  - 0-25 m WILL BE AN ISSUE
- 100 m RESOLUTION IS A SEVERE DRIVER

INTERFACE

SIZE
- ANTENNA ~132 SQ FT
- ELECTRONICS BOX ~2 CU FT (15" X 15" X 15")

POWER
- TOTAL POWER ~ 250W AVERAGE
  - 150 W ON ANTENNA
  - ~100+ FOR ELECTRONICS BOX

WEIGHT 487 lbs (437 antenna/50 elect)

DATA RATE 14 Mbps (ON) - Uncompressible

COVERAGE

SWATH IS OFFSET

- 600 KM SWATH
- DATA COLLECTED FROM 500-1100 KM OFF GROUND TRACK

ISSUES

POWER

- DRIVEN 1st YEAR ICE CONCENTRATION

FOV ANALYSIS

- DETAILS OF IMPACT ON OASIS SOLAR CALIBRATOR FOV HAVE NOT BEEN COMPLETED

CLARIFICATION OF THE DEFINITION OF REQUIREMENTS TERMS ARE STILL IN DOUBT

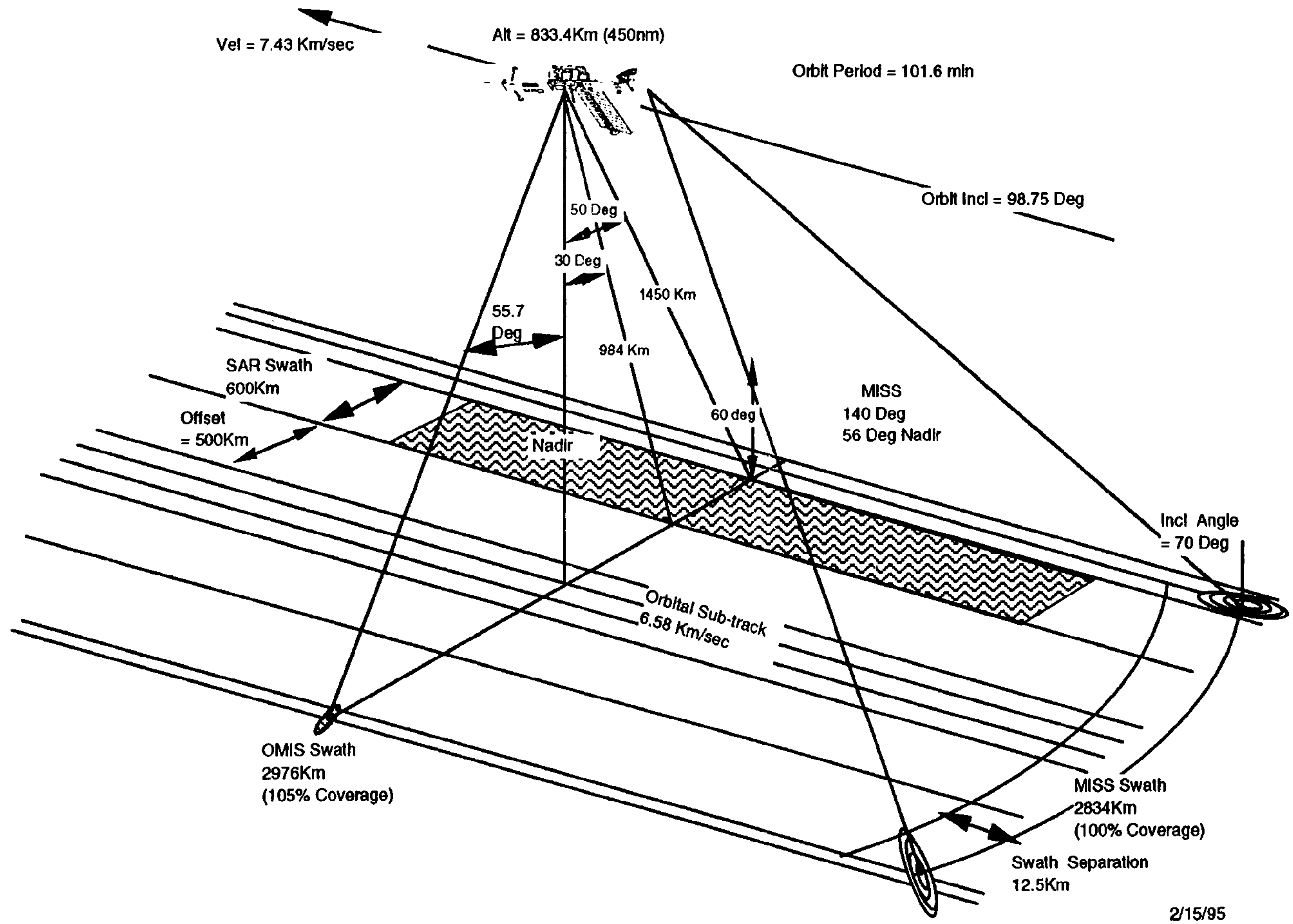
- ICE-EDGE UNCERTAINTY RELATIVE TO MAPPING ACCURACY

3/15/95

CONVERGENCE EFFORT MODIFICATION

DATA COLLECTION GEOMETRY FOR NPOESS SEA ICE ALTERNATIVES

npoess

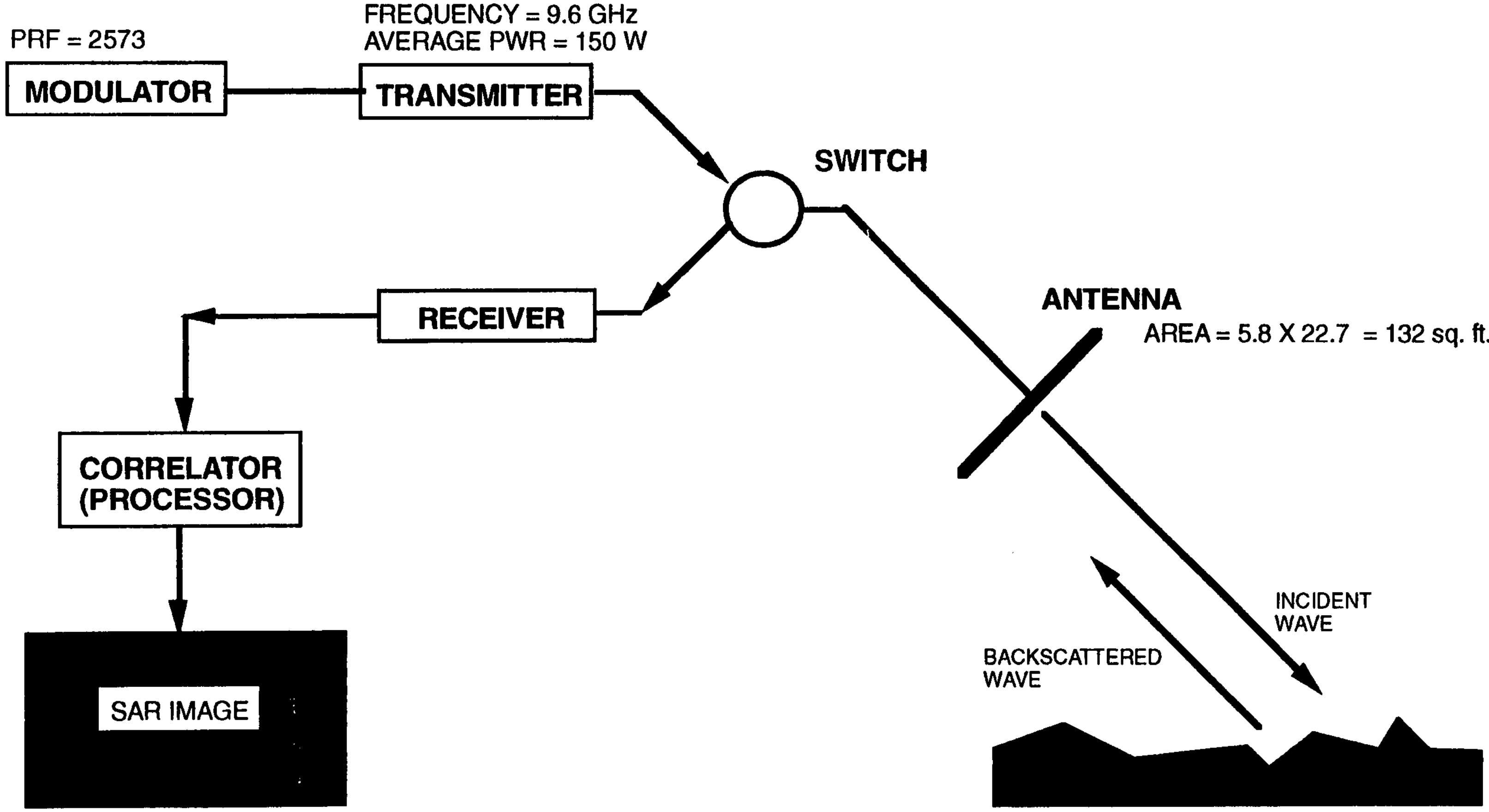


3/15/95

CONVERGENCE EFFORT MODIFICATION

SYNTHETIC APERTURE RADAR (SAR) SIMPLIFIED BLOCK DIAGRAM

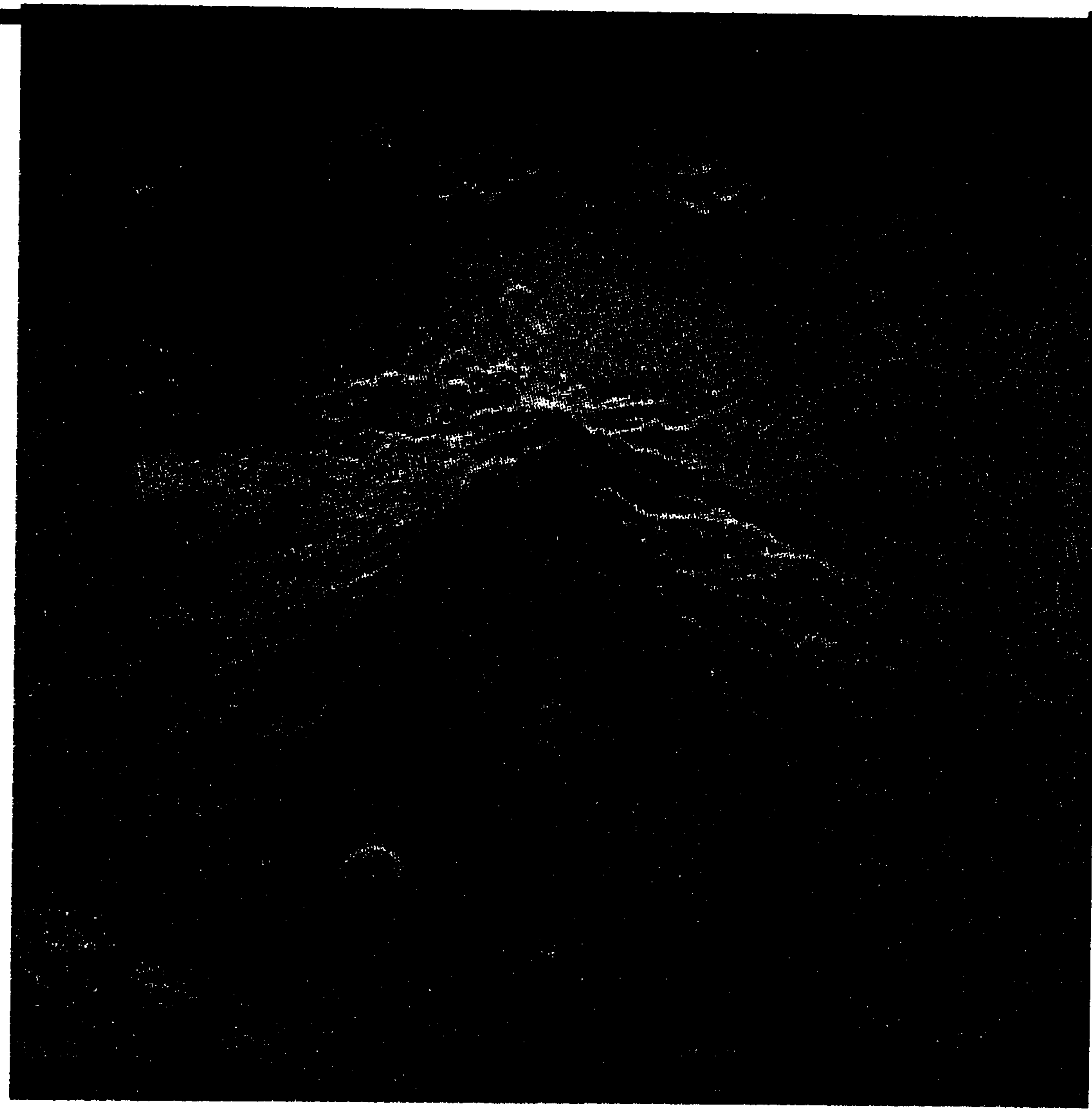
npoess



3/15/95

CONVERGENCE EFFORT MODIFICATION

PROCESSED SAR IMAGE OF MT. SHASTA



CONVERGENCE EFFORT MODIFICATION

FIRST YEAR ICE REQUIREMENTS DRIVER

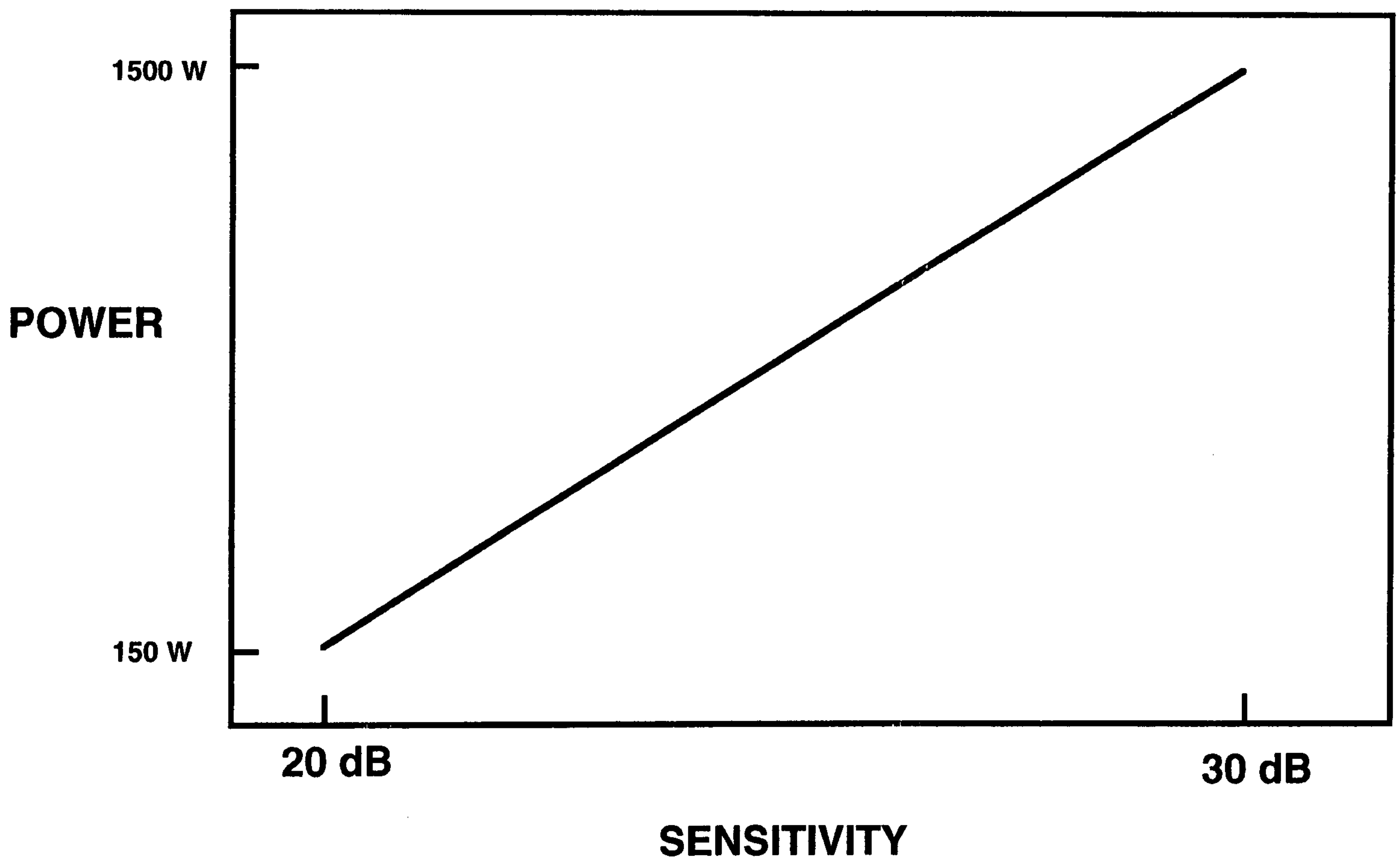
- RETURN SIGNAL LEVEL OF 1st YEAR ICE IS STRESSING
  - 1st YR ICE TENDS TO BE SPECULAR
  - DEPENDENT ON SURFACE SCATTERING (NOT MUCH BULK SCATTERING)

- ICE CONCENTRATION IS A DATA RATE DRIVER
  - PARTICULARLY IMPORTANT FOR 1st YEAR ICE
  - ALSO REQUIRES SIGNIFICANTLY HIGHER ANTENNA POWER LEVELS WHEN COUPLED WITH FIRST YEAR ICE
    - » LESS OF AN ISSUE FOR LEADS/POLYNYAS
    - » NEED TO BETTER UNDERSTAND REQUIREMENT

CONVERGENCE EFFORT MODIFICATION

TOTAL ANTENNA POWER vs SENSITIVITY

npoess



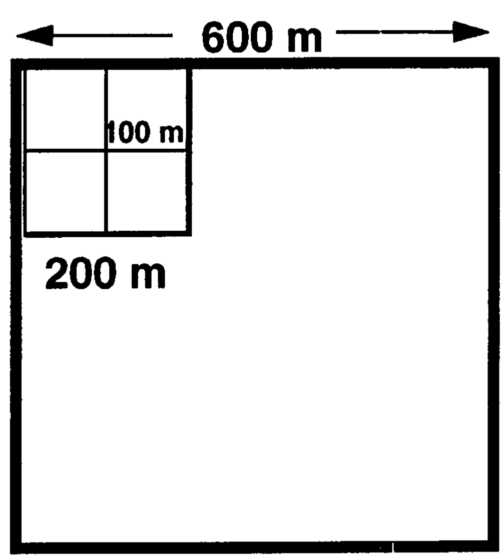
3/15/95

CONVERGENCE EFFORT MODIFICATION

DATA RATE DRIVEN BY ICE CONCENTRATION

- NEED TO BREAK UP A HORIZONTAL SPATIAL RESOLUTION (HSR) CELL IN TO SAMPLE AREAS FOR 0/10, 1/10, ... 10/10

- TO FIRST ORDER CONSIDER A DESIGN THAT GIVES 3X3 SAMPLES UNDER THE 600m HSR CELL
  - 4 SUB-SAMPLES REQUIRED FOR SENSITIVITY AND "SPECKLE" CONSIDERATIONS
  - LEADS TO A FUNDAMENTAL FOOTPRINT OF ~100m

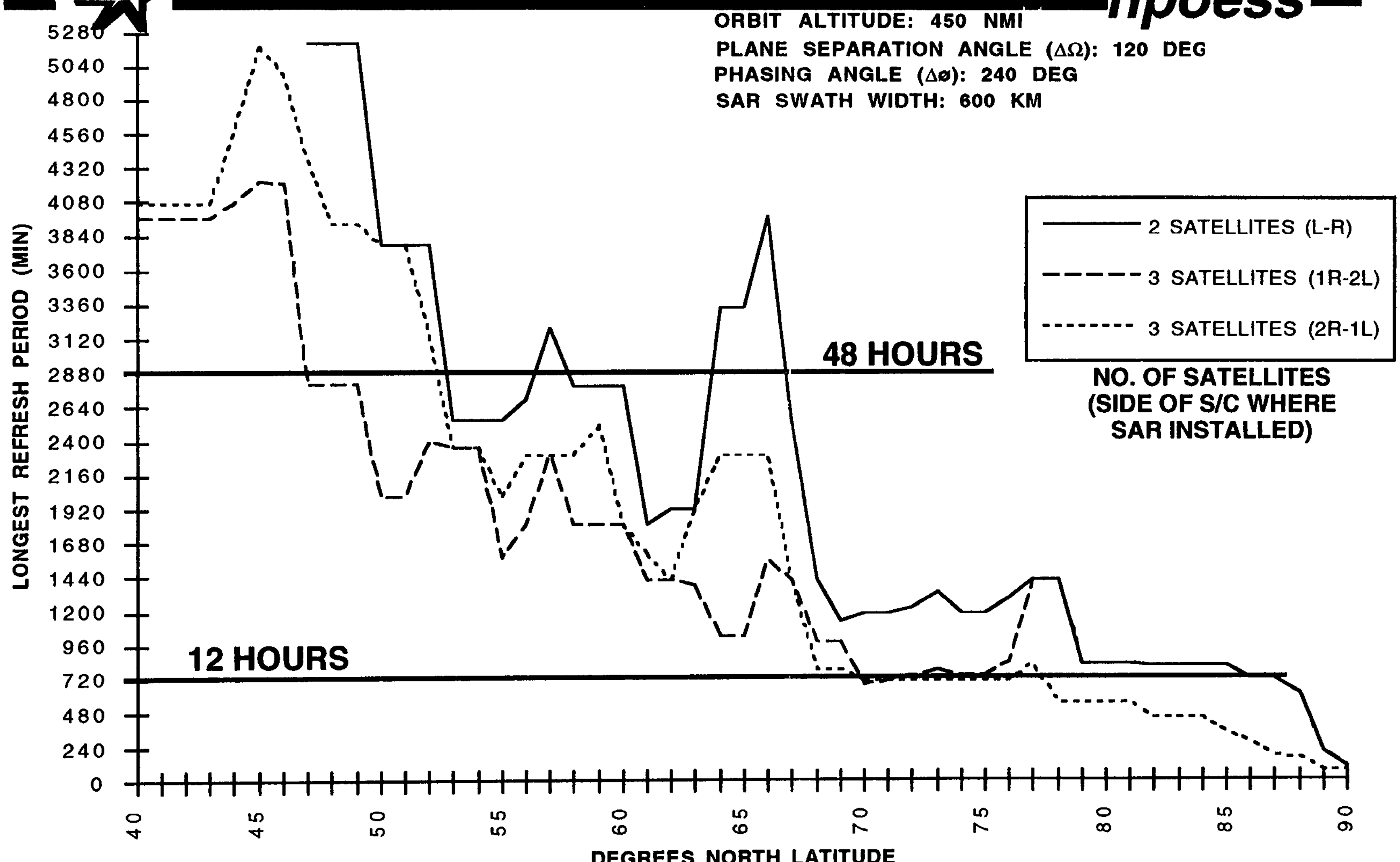


3/15/95

CONVERGENCE EFFORT MODIFICATION

SAR REFRESH PERFORMANCE (600 KM SWATH WIDTH)

npoess



3/15/95

SAR - KEY SPACECRAFT IMPACTS

npoess

- WEIGHT IMPACT:
  - PAYLOAD @ 487 lbs (220kg), ADDITIONAL S/C WT OF 185 lbs(85kg) FOR A TOTAL WT OF 672 lbs (305kg).
  - FOR S/C WITH 'BASIC' + AIRS THE TOTAL = 5418 lbs (2457kg)
  - 90% OF LAUNCH TARGET (6000 lbs = 85% RATED)

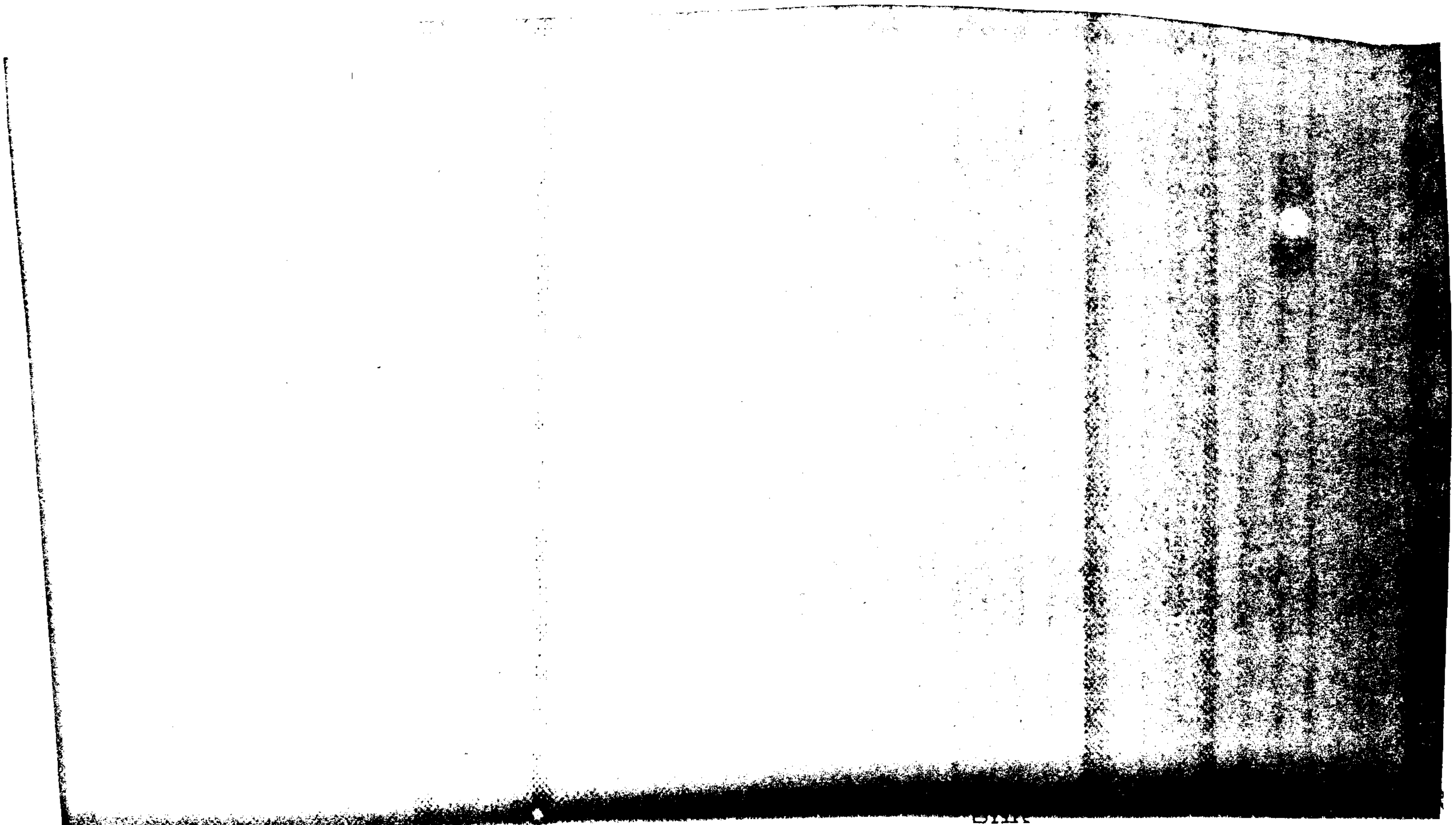
- POWER IMPACT: (WORST CASE OF CONTINUOUS USAGE)
  - PAYLOAD @ 300 WATTS, ADDITIONAL S/C LOAD OF 45 W FOR A TOTAL P/L OF 345 W. TOTAL S/C LOAD = 2110 W.
  - SOLAR ARRAY INCREASES 831 W TO 5142 W BOL
    MAXIMUM CAPABILITY ~ 5600 W BOL
  - BATTERIES REMAIN AT 3 90 A-H UNITS (142 A-H REQD)

STOWED SAR

- STOWED
  - DELTA 5' EXTENDED SHROUD
  - 2 ANTENNA PANELS,
  - ONE HINGE

DEPLOYED SAR

- DEPLOYED: BOUNDED BY DEEP SPACE FOV, NADIR FOV, MISS FOV, AND SOLAR ARRAY TRACKING AREA.



ALTIMETER

SPACECRAFT CONCLUSIONS

- AN X-BAND SAR CAN BE ACCOMMODATED
- SPACE IS VERY LIMITED - STOW & DEPLOYED
- SOME PAYLOAD COMBINATIONS MAY BE LIMITED
- OTHER ISSUES:
  - NEAR FIELD INTERFERENCE WITH SOLAR ARRAY
  - RFI/EMI WITH SENSORS (e.g., AVM, RPAD, COMM, etc)
  - SOLAR CALIBRATORS AT HIGH BETA ANGLES (0530 NODAL X'G)
  - SAR ALIGNMENT (FLATNESS TO 2 mm)
  - DATA HANDLING AT 14X3 MBPS RATE
  - ADEQUATE EARTH COVERAGE WITH ANTENNA ONLY ON SUN SIDE

CONVERGENCE EFFORT MODIFICATION

SAR IDPS IMPACTS

npoess

- MINIMAL PROCESSING IMPACT
  - ADDS 16 MINUTES OF PROCESSING TIME AT END OF OTHER MISSION DATA PROCESSING I.E. REDUCES UNUSED TIME TO 34 MINUTES
- SOFTWARE IMPACT: REQUIRES 15K MODIFIED AND 35K NEW LINES OF CODE
- HARDWARE IMPACT:
  - MASS STORAGE: ADD 16 GBYTES (I.E . 2 ORBIT STORAGE AREA)
  - RANDOM ACCESS MEMORY: ADD 800 MBYTES
- USE OF CENTRAL SITE FEP FOR SAR DATA WILL ONLY SLIGHTLY REDUCE AVAILABILITY OF BACK-UP FEP FOR PRIMARY MISSION DATA

CONVERGENCE EFFORT MODIFICATION

SMD DATA RATE REQUIREMENTS
14 mbps SAR

npoess

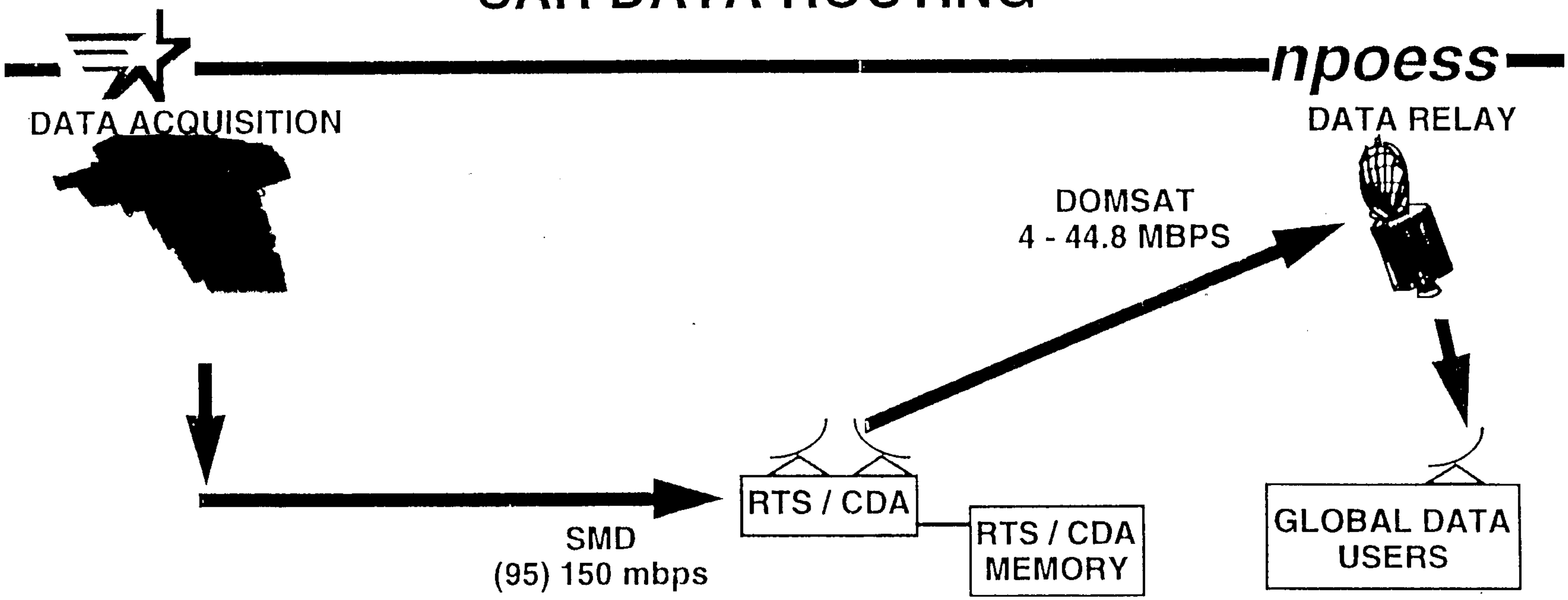
PARAMETER	REQUIREMENT	DERIVED REQUIREMENT
Sensor Data Rate	BASELINE - FULL RATE - AVG RATE	Data Rate with 15% overhead
0530 S / C	4.55 mbps - 18.55 mbps - (9.03 mbps)	5.2 mbps - 21.3 mbps - (10.38 mbps)
0930 S / C (EUMETSAT)	6.04 mbps - 20.04 mbps - (10.52 mbps)	6.9 mbps - 23.0 mbps - (12.10 mbps)
1330 S / C	5.98 mbps - 19.98 mbps - (10.46 mbps)	6.9 mbps - 23.0 mbps - (12.03 mbps)
Mission Data Storage	Data for 2 orbits	84.8 Gb - 280.6 Gb (147.66 Gb)
Mission Data Offload	Data for 1 orbit	
0530 S / C	27.8 Gb - 113.2 Gb - (55.10 Gb)	31.9 Gb - 130.0 Gb - (63.34 Gb)
0930 S / C (EUMETSAT)	36.9 Gb - 122.3 Gb - (64.19 Gb)	42.4 Gb - 140.3 Gb - (73.83 Gb)
1330 S / C	36.5 Gb - 121.9 Gb - (63.83 Gb)	42.0 Gb - 140.3 Gb - (73.41 Gb)
SMD Downlink	X-Band	8.255 GHz (TBR)
Data Rate (8.5 min contact without gaps)	Data for 1 orbit	90 mbps - 285 MBPS - (150 mbps)
Downlink Sites	3 to 4 CDA / RTS	FTS, WTS, (TBD)
Timeliness	Downlink 1 per orbit period	Data delivered and processed in 130 min (SAR 180 min)
Data Format	TBD	CCSDS

BASED ON AVERAGE SAR RATE OF 4.48 mbps for 32% OF ORBIT

3/15/95

CONVERGENCE EFFORT MODIFICATION

SAR DATA ROUTING



FOUR OPTIONS CONSIDERED ...DELAYED DATA ROUTING SELECTED

DELAYED SAR DATA ROUTING	INCREASE S / C MEMORY 75% (12% FOR 2.1 MBPS) INCREASE SMD DATA RATE TO 150 MBPS (95 mbps FOR 2.1 MBPS), INCREASE CDA / RTS DATA RECORDING CAPACITY ROUTE SAR DATA AFTER ALL OTHER SDRS ; NO CHANGE TO DOMSAT THROUGHPUT CAPACITY

3/15/95

CONVERGENCE EFFORT MODIFICATION

SAR CAPABILITIES AND DESIGN EXTREMES

npoess

- "RELATIVELY" SIMPLE, LOW-COST SOLUTION FOR MINIMUMS IN THE FOLLOWING AREAS
  - ICE BOUNDARY EDGE
  - ICE THICKNESS TO 2 m
  - LEADS/POLYNYAS
  - ICE AGE IN 2-4 KM HORIZONTAL SPATIAL RESOLUTIONS

- HIGH COST SOLUTION FOR GOALS
  - 1st YEAR ICE CONCENTRATION IN 100m LEADS TO >100Mbps DATA RATE SOLUTIONS
  - HIGH POWER > 1-3 kW (AVE)
  - USE OF SAR FOR HELP WITH OTHER EDRs

GUIDANCE NEEDED ON CLARIFICATIONS OF SEA-ICE REQUIREMENTS FROM 31 JAN ACTION ITEMS

5/95

SUMMARY / RECOMMENDATION

A SAR ON NPOESS:

- O OCCUPIES THE HIGH END OF MEDIUM RISK FOR EVEN THE LOW COST, LOW POWER, SINGLE EDR IMPLEMENTATION.
- O COULD BE SUBJECT TO ANTENNA DEFORMATIONS DURING SURVIVABILITY SITUATIONS (TBR)
- O IS ON THE LOW END OF COST-BENEFIT RATIO (2X MISS LCC, 1.5X OASIS LCC)
- O INCREASES PROGRAM RISK AND COMPLEXITY (ANTENNA PLACEMENT, DEPLOYMENT, EMI, SESS INTERACTIONS, COMM DATA RATES)

SAR DATA FOR SEA ICE CAN BE OBTAINED

- O FROM RUSSIANS, CANADIANS, JAPANESE
- O OTHER US NATIONAL RESOURCES
- O IN A COMMERCIAL VENUE LIKE U.S. SPACE COMMAND

3/15/95

PRESENTATION OUTLINE

- ***MISS CONCEPT DEVELOPMENT OVERVIEW***
  - CONCEPT DEVELOPMENT FLOW
  - PREVIOUS MISS CONCEPT

- ***NPOESS MICROWAVE SUITE CONCEPT DEVELOPMENT***
  - OPTIMIZATION OF MICROWAVE SOUNDING IMPLEMENTATION
  - EVALUATION OF OPTIMUM MICROWAVE SOUNDING SUITE
  - REQUIREMENTS ISSUE #88 (FOOTPRINT GROWTH) IMPACTS ON SOUNDER SELECTION
  - COVERAGE IMPACT ON SOUNDER SELECTION
  - UPPER AIR SOUNDING OPTIONS
  - MICROWAVE IMAGER FEATURES
  - VIABILITY OF HIGH INCIDENCE ANGLE RETRIEVALS

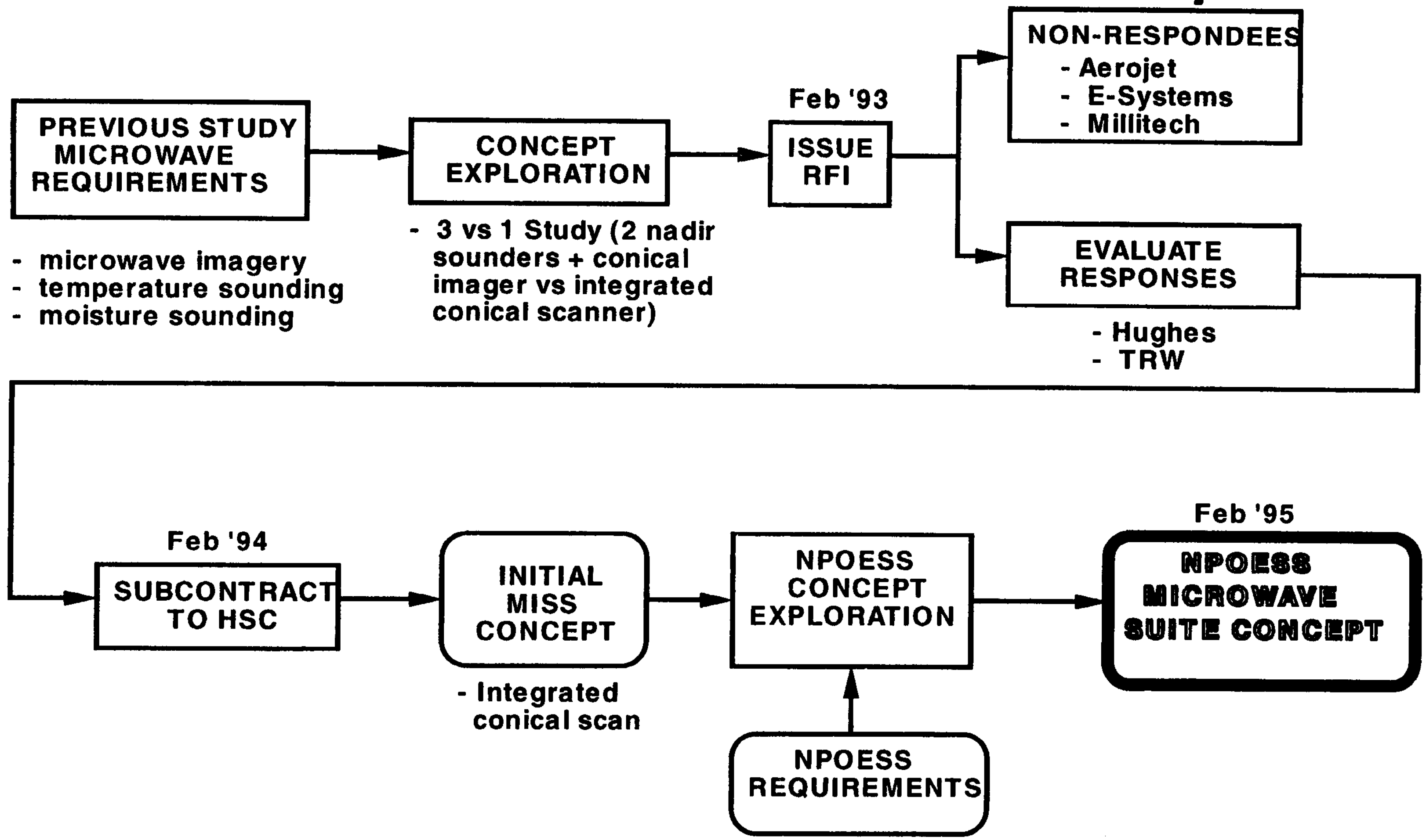
- ***NPOESS MICROWAVE SUITE***

- ***ISSUES***

CONVERGENCE EFFORT MODIFICATION

MISS CONCEPT DEVELOPMENT OVERVIEW

npoess

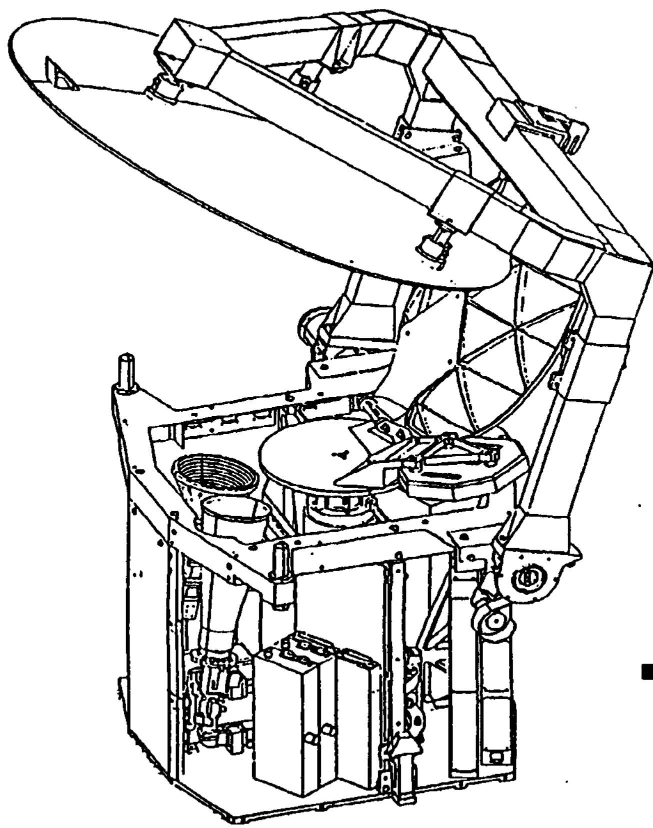


CONVERGENCE EFFORT MODIFICATION

INITIAL MISS CONCEPT PROVIDED INTEGRATED MICROWAVE IMAGERY & SOUNDING

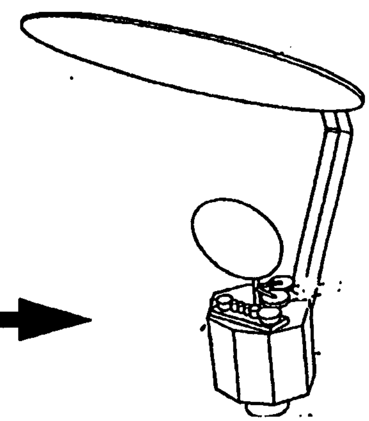
npoess

Conceptual Design (based on TMI)



dmsp/noaa

MISS



MISS DATA

SIZE: 204 cm ANTENNA
17 cm BUCKET

WEIGHT: 95 kg

POWER: 79 w

DATA RATE: 32.3 kbps

MISS RE-EVALUATED IN TERMS OF NPOESS REQUIREMENTS

3/15/95

CONVERGENCE EFFORT MODIFICATION

OPTIMIZATION OF NPOESS MICROWAVE SOUNDER IMPLEMENTATION

npoess

- **CONSIDERED CONVERGED SOUNDER SOLUTIONS INCLUDING:**
  - EOS-TYPE SOUNDING SUITE (CROSS-TRACK SUITE OF IR SOUNDER & MICROWAVE TEMPERATURE & MOISTURE SOUNDERS, CONICALLY-SCANNED MISS WITH IMAGERY CHANNELS ONLY)
  - TEMPERATURE SOUNDING USING CONICALLY-SCANNED MISS ONLY
  - COMBINATION (CROSS-TRACK IR SOUNDER & CONICALLY-SCANNED MISS)

- ***OPTIMUM SOLUTION DETERMINED TO BE EOS-TYPE SOUNDING SUITE***

	PARAMETER	IMPLEMENTATION OPTIONS		
		EOS-TYPE SUITE	MISS ONLY	IR SOUNDER & MISS
NPOESS REQUIREMENTS	COVERAGE	Meets Requirements	Exceeds Requirements	Meets Requirements
	SPATIAL RESOLUTION	Meets Requirements	Doesn't Meet Requirements	Meets Requirements
	ALTITUDES SOUNDED	Meets Requirements	Doesn't Meet Requirements	Doesn't Meet Requirements
	VERTICAL RESOLUTION	Meets Requirements	Doesn't Meet Requirements	Meets Requirements
	SOUNDING ACCURACY	Meets Requirements	Doesn't Meet Requirements	Meets Requirements
	SOUNDING PRECISION	Meets Requirements	Doesn't Meet Requirements	Meets Requirements
	CO-REGISTRATION	Meets Requirements	N/A	Doesn't Meet Requirements

Doesn't Meet Requirements | Meets Requirements | Exceeds Requirements

3/15/95

CONVERGENCE EFFORT MODIFICATION

PREFERRED MICROWAVE SOUNDER SUITE BASED ON SOUNDER IMPLEMENTATION

npoess

- EVALUATED FOUR CANDIDATE EOS-TYPE MICROWAVE SOUNDER SUITES

1) ADVANCED ATMOSPHERE TEMPERATURE SOUNDER (AATS) TO MEET 50km RESOLUTION AT EDGE OF SCAN (STUDIED IN PREVIOUS STUDY), AND MHS
2) AMSU-A & MHS
2) MICROWAVE TEMPERATURE SOUNDER (AMSU-A FOLLOW ON) & MHS
3) EXISTING NOAA TOVS (SSU/MSU) WITH ADDITION OF SSM/T2

		SOUNDER SUITE			
EVALUATION CATEGORY	WEIGHT	AATS & MHS	AMSU-A & MHS	MTS & MHS	TOVS
REQUIREMENTS	30%	10.00	9.00	9.00	4.00
DESIGN APPROACH	25%	9.00	9.00	9.00	4.00
MATURITY	10%	7.50	9.00	8.00	10.00
COST	20%	6.50	9.00	7.50	10.00
RISK	15%	7.50	9.00	8.00	9.00
TOTAL SCORE		8.43	9.00	8.45	6.55
		OPTION A	OPTION B		

TWO POTENTIAL OPTIONS TO BEST MEET NPOESS REQUIREMENTS

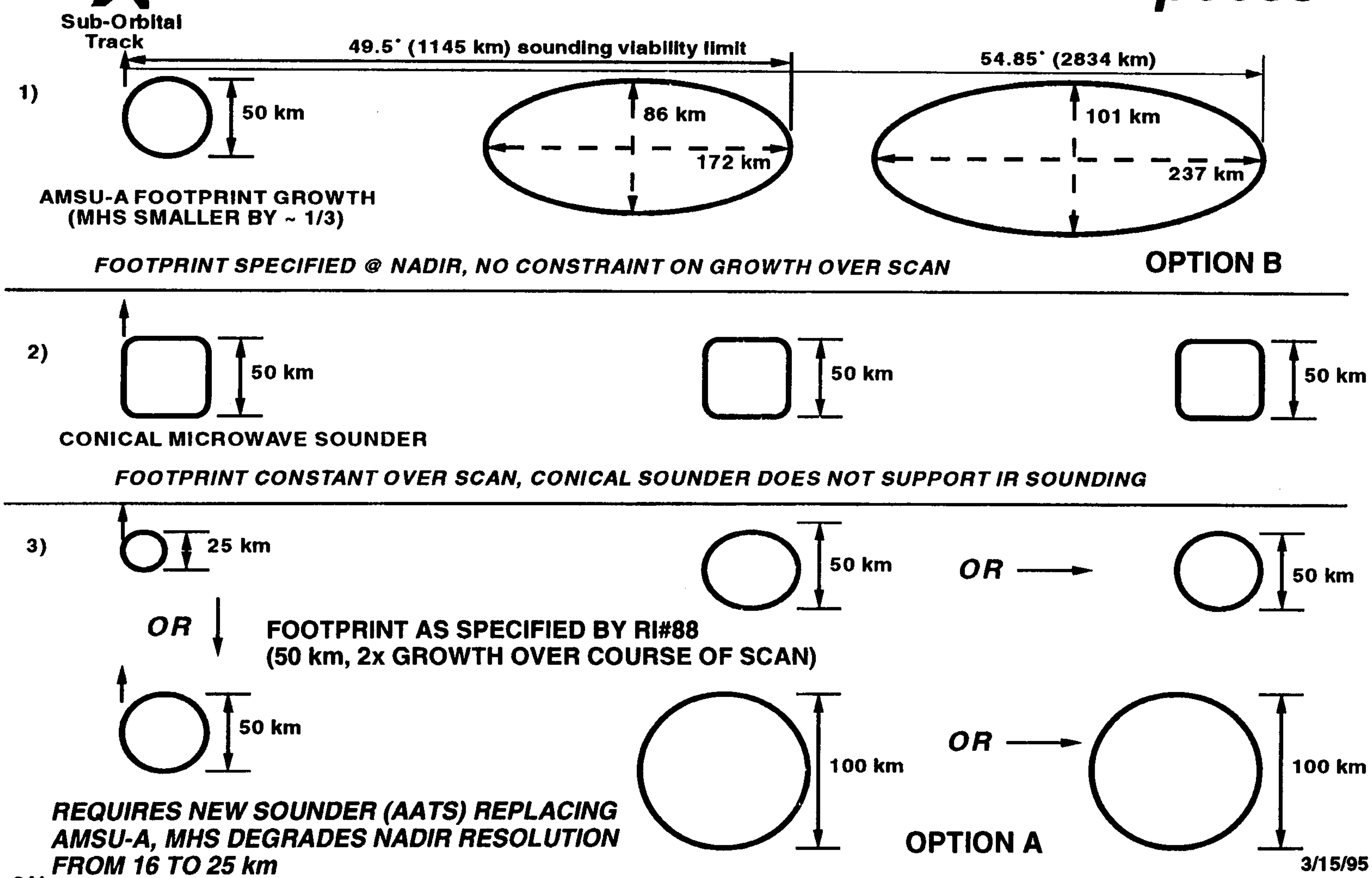
RFIs ISSUED TO AEROJET (AMSU-A), MATRA (MHS) FOR FURTHER DATA ON AMSU-A & MHS. RESPONSES MAY ALTER SCORING

3/15/95

CONVERGENCE EFFORT MODIFICATION

REQUIREMENTS ISSUE #88 IMPACTS MICROWAVE SOUNDER SELECTION

npoess



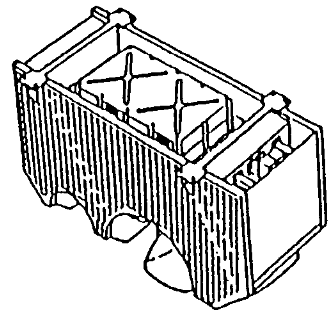
3/15/95

CONVERGENCE EFFORT MODIFICATION

ADVANCED ATMOSPHERIC TEMPERATURE SOUNDER (OPTION A)

npoess

AATS REQUIRED TO OBTAIN 50 km RESOLUTION AT SCAN EDGE



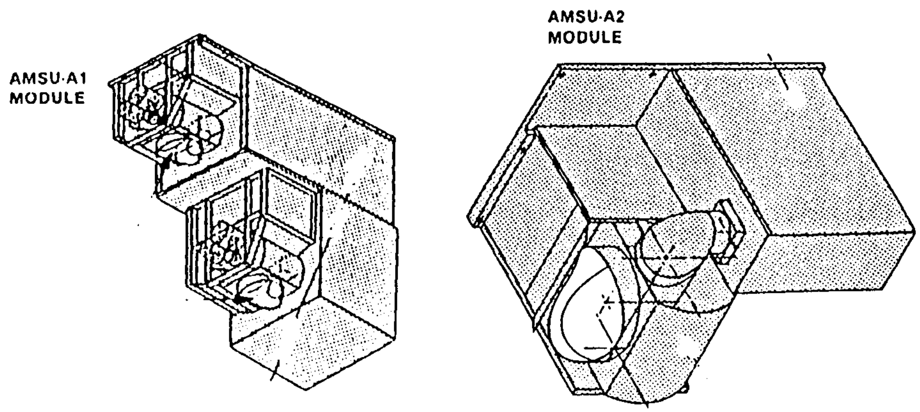
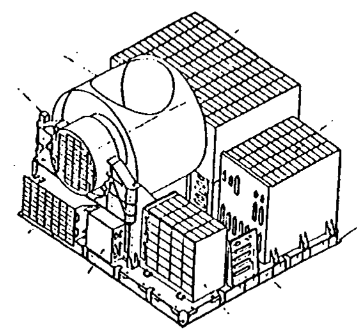
COVERAGE	81%	100%
SENSOR TYPE	NADIR	NADIR
SOUNDING FUNCTION	TEMPERATURE	TEMPERATURE
REFLECTOR 1 DIA (@ 50.3 GHz)	66 cm	83 cm
REFLECTOR 2 DIA (@ 57.3 GHz)	58 cm	72 cm
FOOTPRINT - NADIR - SCAN EDGE	 12 km 50 km	 10 km 50 km
SIZE (cm)	170 x 76 x 83	201 x 93 x 100
WEIGHT (lb)	195	212
POWER (w)	99	103
DATA RATE (bps)	21914	35887

3/14/95

CONVERGENCE EFFORT MODIFICATION

AMSU-A & MHS (OPTION B) OVERVIEW

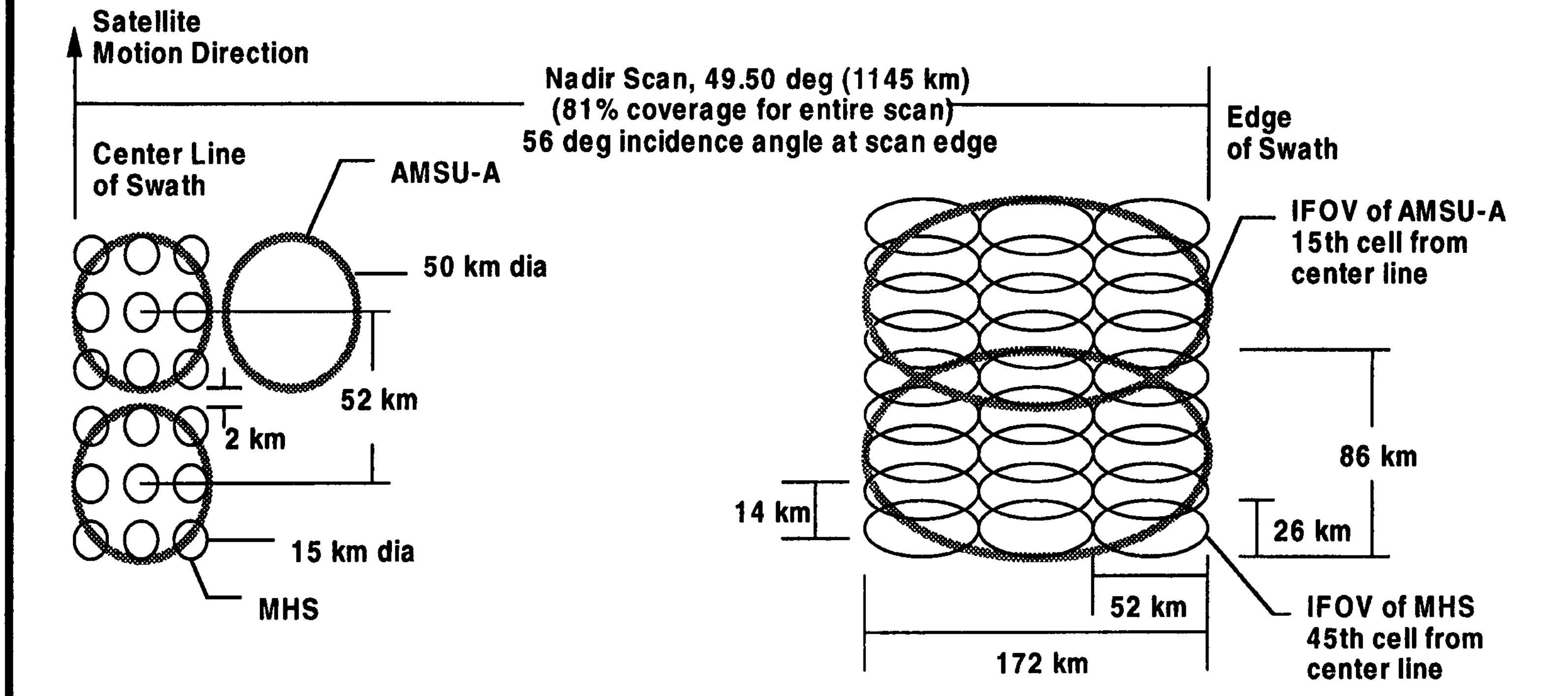
npoess

Advanced Microwave Sounding Unit - A (AMSU-A)		Microwave Humidity Sounder (MHS)
		
Sensor Type	Nadir (two 5.9 in reflectors) (one 12 in reflector)	Nadir (one 9 in reflector)
Sounding Function	Temperature	Moisture
Sounding Depth	0 to 47 km	0 to 10 km
Frequencies	A1: 12 @ 50 - 57.29 GHz, 1 @ 89 GHz A2: 23.8 & 31.4 GHz	89, 150 & 183 GHz
Sounding Footprint	50 km nadir 86 x 172 km edge of scan	15 km nadir 26 x 52 km edge of scan

3/14/95

AMSU-A/MHS IFOV OVERLAY

AMSU-A / MHS IFOV OVERLAY PATTERN @ 833 km (Shown one - half of swath)



REQUIREMENTS ISSUES:

- ***HORIZONTAL SPATIAL RESOLUTION SPECIFIED AT NADIR OR EDGE-OF-SCAN?***
- ***SOUNDER COVERAGE***

3/15/95

CONVERGENCE EFFORT MODIFICATION

MICROWAVE SOUNDER SPATIAL RESOLUTION / COVERAGE

npoess

SPATIAL RESOLUTION SPECIFIED AT NADIR OR EDGE OF SCAN?

- 50 km SPECIFIED AT NADIR ALLOWS USE OF AMSU-A, *BUT ...*
- 2x DEGRADATION OVER COURSE OF SCAN ELIMINATES AMSU-A AND REQUIRES AATS, *BUT KEEP IN MIND THAT ...*
- MICROWAVE SOUNDER *AUGMENTS* INFRARED SOUNDINGS

THEREFORE

- RECOMMEND 50 km RESOLUTION AT NADIR & LESS THAN 4x DEGRADATION OVER SCAN WHICH WOULD ALLOW AMSU-A UTILIZATION

SOUNDING COVERAGE

- SOUNDING COVERAGE > 81% ELIMINATES CONSIDERATION OF AMSU/MHS, *BUT ...*
- SOUNDING RETRIEVALS DEGRADE FROM ~1K TO >2K FOR COVERAGE > 81%

THEREFORE

- RECOMMEND SOUNDING COVERAGE REQUIREMENT OF ~81%, WITH 100% GOAL

3/15/95

CONVERGENCE EFFORT MODIFICATION

SOLUTION DOMAIN TO NPOESS UPPER AIR SOUNDING REQUIREMENTS

npoess

UPPER AIR SOUNDING

- INFRARED PRESSURE MODULATOR RADIOMETERS
- MICROWAVE UPPER AIR SOUNDING

INFRARED PRESSURE MODULATOR RADIOMETERS

ADVANTAGES

- IR PMRs (FROM BAe, NOW MATRA MARCONI) HAVE FLOWN & PERFORMED WELL ON TIROS-N & NIMBUS
- IR ALGORITHMS ARE SIMPLE, WELL UNDERSTOOD LINEAR ESTIMATION TECHNIQUES
- MEETS NPOESS UPPER AIR SOUNDING REQUIREMENTS

DISADVANTAGES

- SEPARATE SENSOR

MICROWAVE UPPER AIR SOUNDING

ADVANTAGES

- INTEGRATED INTO EXISTING MISS SENSOR
- AVOIDS SEPARATE SENSOR DEVELOPMENT COSTS
- MINOR MISS IMPACT ON SIZE, WEIGHT, POWER

DISADVANTAGES

- NO FLIGHT HISTORY (SSMIS UNDER DEVELOPMENT, MTS TERMINATED DURING PHASE B)
- DIFFICULT AS TEMPERATURES MEASURED AT ~60 GHz REQUIRING NARROW RF BANDWIDTHS TO AVOID OXYGEN BAND, AND INCREASING ΔT DRIFT SENSITIVITY
- SENSITIVE TO ZEEMAN SPLITTING (CHANGES IN SPECTRAL FEATURE WIDTH AS A FUNCTION OF THE EARTH'S MAGNETIC FIELD)
- DOES NOT SUPPORT NPOESS SOUNDING IMPLEMENTATION BASELINE

MATRA MARCONI RESPONDED TO RFI WITH AN IR UPPER AIR SOUNDER CONCEPT THAT MEETS NPOESS UPPER AIR SOUNDING REQUIREMENTS

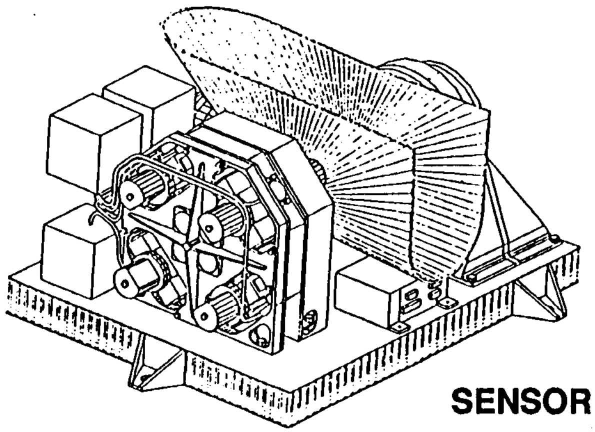
3/15/95

CONVERGENCE EFFORT MODIFICATION

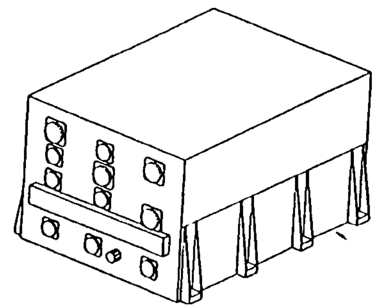
MATRA UPPER AIR SOUNDER
- CONCEPT -

npoess

MATRA UAS IS AN INFRARED PRESSURE MODULATION RADIOMETER USING PRESSURE MODULATOR CELLS WITH CO_2 IN CONCERT WITH MOLECULAR SIEVE AND TRIGLYCINE SULPHATE DETECTORS. UAS RFI RESPONSE UNDER ANALYSIS.



SENSOR



ELECTRONICS

SIZE: SENSOR - 65 x 45 x 25 cm
ELECTRONICS - 35 x 26 x 20 cm

WEIGHT: 39 kg

POWER: 80 w

DATA: <7 kbps

PROPOSED BASELINE CO_2 PRESSURES

Channel 1: 0.5 to 1 mb
Channel 2: 1 to 2 mb
Channel 3: 4 to 8 mb
Channel 4: 16 to 32 mb

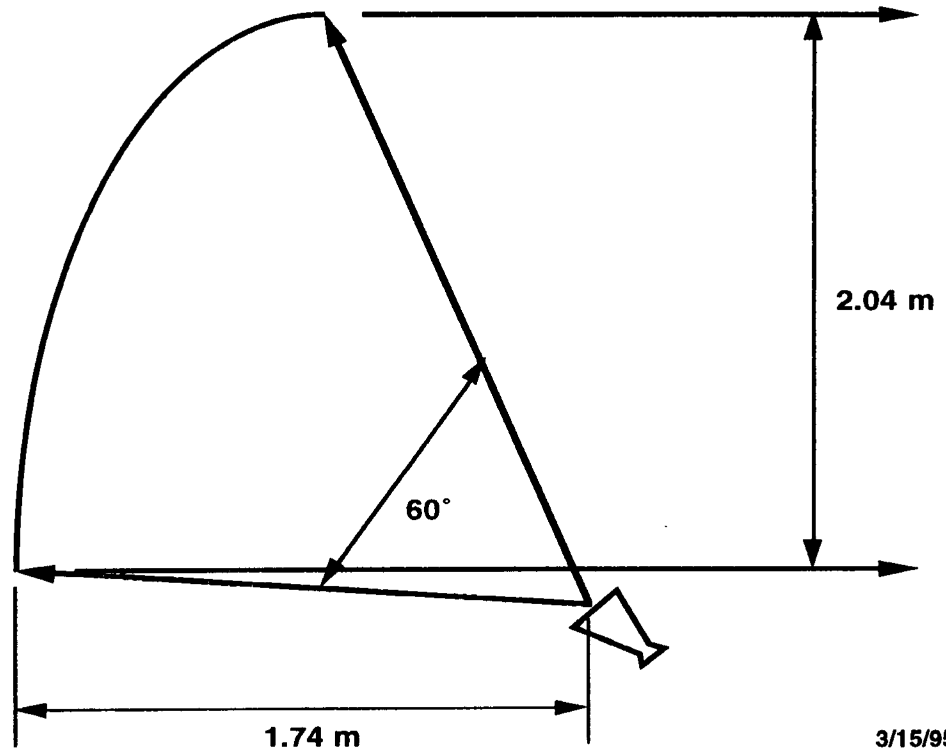
LINEAR COMBINATIONS USED TO INFER TEMPERATURE AT OTHER LEVELS

3/3/95

NPOESS ADVANCED MICROWAVE IMAGER

npoess

- OFFSET PARABOLOID WITH SAME F/D RATIO AS PREVIOUS SENSORS (SSM/I, TMI)
- 2.04 m DIAMETER REFLECTOR WITH 1.74 m FOCAL LENGTH (HIMMS/MIMR HERITAGE)
- 50 km RESOLUTION @ 19 GHz, 100% COVERAGE OBJECTIVE (70 deg incidence angle)
- FOUR FREQUENCY FEEDHORN, LOW DESIGN RISK, PROVIDES BEST RECEIVER PERFORMANCE:
  - SSM/I 4-FREQUENCY HORN (19.35, 23.8, 37 & 89 GHz)
  - DIRECT DETECTION TO 37 GHz
  - LOW NOISE AMPLIFIER AT 89 GHz PROVIDES BEST SENSITIVITY
- EXISTING TMI BUCKET CAN ACCOMMODATE EXTRA FEEDHORNS
- EXPLORING POSSIBILITY OF INCORPORATING 10.65 & 6.8 GHz FEEDHORNS AND ENHANCE SEVERAL EDRs (i.e. OCEAN WIND SPEED, SOIL MOISTURE, ICE)
- POTENTIAL CROSS-POLARIZATION IMPLEMENTATION (WIND DIRECTION)



3/15/95

CONVERGENCE EFFORT MODIFICATION

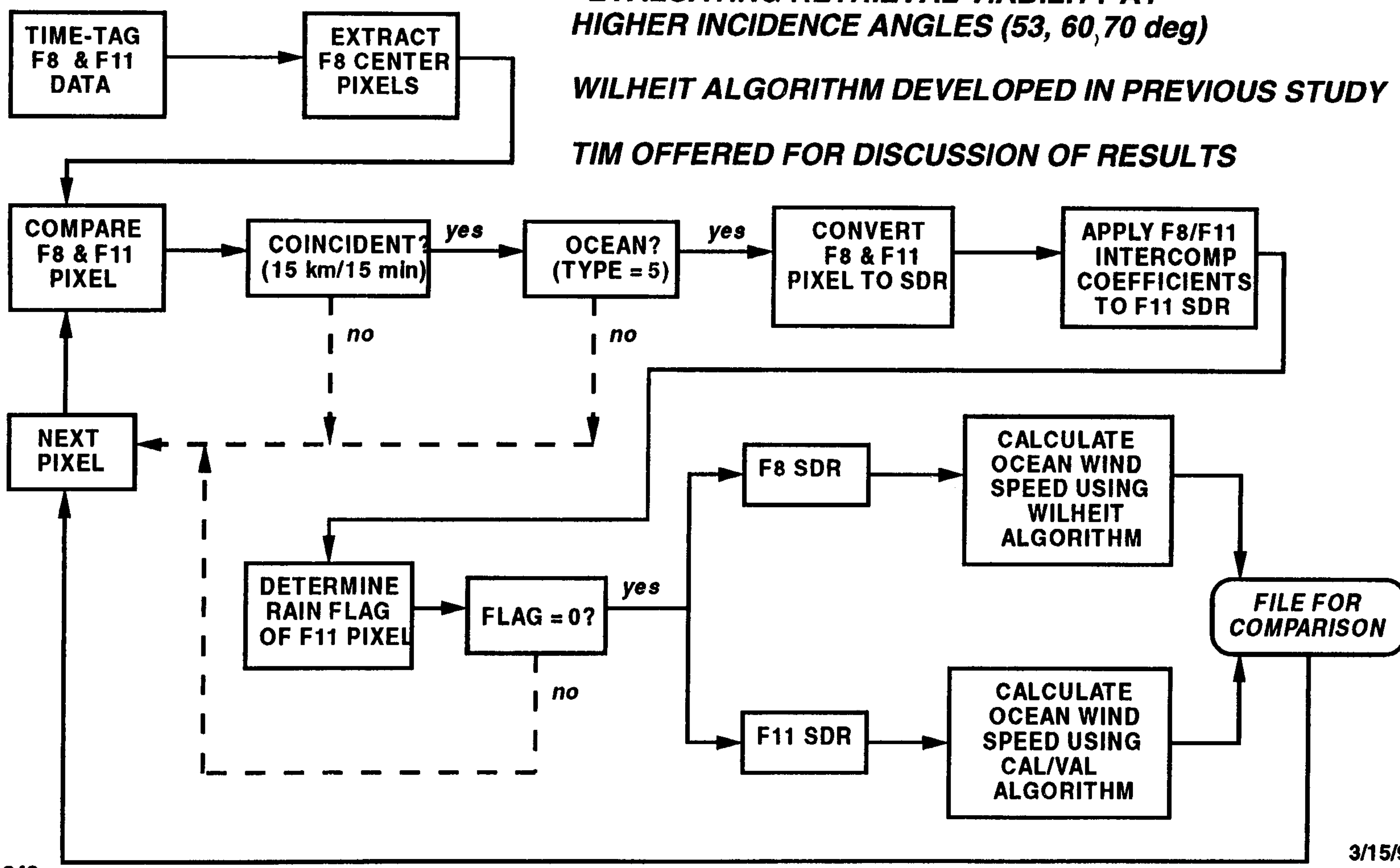
TILT EXPERIMENT SDR ANALYSIS FLOW

npoess

EVALUATING RETRIEVAL VIABILITY AT HIGHER INCIDENCE ANGLES (53, 60, 70 deg)

WILHEIT ALGORITHM DEVELOPED IN PREVIOUS STUDY

TIM OFFERED FOR DISCUSSION OF RESULTS



3/15/95

NPOESS MICROWAVE SUITE

npoess

SOUNDING SUITE PROVIDES SPATIAL & TEMPORAL CO-REGISTRATION OF DATA USING LOW-RISK SENSORS OF PROVEN HERITAGE

- AMSU-A (Aerojet) & MHS (Matra) PROVIDE BEST POTENTIAL TO MEET NPOESS REQUIREMENTS
  - SUPPORTS CROSS-TRACK SCANNING REQUIREMENTS OF AIRS
  - RELATIVELY LOW RISK AND LOW COST
  - CURRENTLY UNDER DEVELOPMENT
  - RECOMMEND REVISION OF A-SPEC REQUIREMENTS ON COVERAGE/SPATIAL RESOLUTION TO ATTAIN FULL REQUIREMENTS COMPLIANCE

- INFRARED UPPER AIR SOUNDER (Matra) MOST VIABLE OPTION TO MEET UPPER AIR SOUNDING REQUIREMENTS
  - LOWEST RISK (FLIGHT PROVEN)
  - SUPPORTS OTHER CROSS-TRACK SCANNING SOUNDERS (AIRS, AMSU-A & MHS)

HUGHES MICROWAVE IMAGER SUPPLIER MAXIMIZES APPLICABLE FLIGHT HERITAGE AND LOWERS RISK

- SUBSTANTIAL PROVEN HERITAGE OF SSM/I, TMI UNDER DEVELOPMENT, TECHNOLOGY LEVERAGE FROM HIMMS CONTRACT (MIMR PROGENITOR)

CONVERGENCE EFFORT MODIFICATION

ISSUES

npoess

- **MAXIMUM REALIZABLE INCIDENCE ANGLE FOR IMAGERY AND/OR SOUNDING EDR RETRIEVALS**
  - ACCURATE SOUNDING RETRIEVALS APPEAR LIMITED TO EIA < 60 deg
  - TILT EXPERIMENT ASSESSING IMAGERY RETRIEVALS AT HIGHER INCIDENCE ANGLES
  - AT WHAT INCIDENCE ANGLE DOES MICROWAVE IMAGERY RETRIEVALS (100% COVERAGE DESIRED/REQUIRED) ENCOUNTER "FURTHER PROOF REQUIRED"

- **IMPORTANCE OF UPPER AIR SOUNDINGS**
  - JUSTIFICATION OF INFRARED UPPER AIR SOUNDER

- **AMSU-A & MHS OFFER COST-EFFECTIVE CAPABILITY TO MEET NPOESS REQUIREMENTS**
  - HORIZONTAL SPATIAL RESOLUTION, SCAN GROWTH AND COVERAGE ISSUES NEED TO BE RESOLVED
  - SENSOR LIFETIME AND SURVIVABILITY REMAIN CONCERNS
  - RFI's ISSUED TO AEROJET & MATRA FOR FURTHER DATA

WILL CONTINUE TO WORK NPOESS MICROWAVE SUITE CONCEPT EXPLORATION TO SUPPORT JULY SRR

3/15/95

NEAR-TERM PLANS

- FINALIZE SOUNDER SUITE BASED ON REQUIREMENTS ISSUE RESOLUTION AND RFI RESPONSES

- PURSUE CONCEPT EXPLORATION OF MICROWAVE IMAGER. IDENTIFY IMPACTS OF INCORPORATION OF ADDITIONAL CAPABILITY (10.65 GHz, 6.8 GHz, CROSS-POLARIZATION)

- ANALYZE TILT DATA TO ASSESS HIGH INCIDENCE ANGLE VIABILITY. SCHEDULE SMALL TIM WITH AEROSPACE.

- ANALYZE MATRA UAS RFI RESPONSE AND ASSESS INCORPORATION OF SENSOR INTO BASELINE

CONVERGENCE EFFORT MODIFICATION

SES STATUS

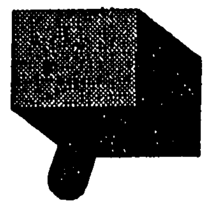
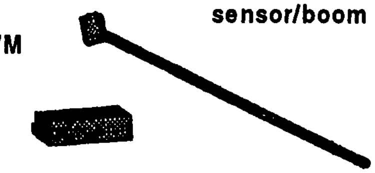
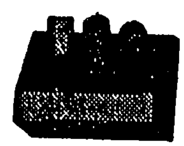
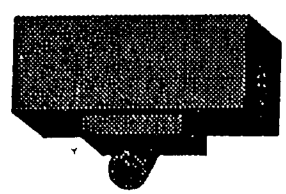
npoess

KEY ACCOMPLISHMENTS THIS PERIOD

- STARTED PROCESSING TOPEX/GPSR DATA FOR VERIFICATION OF 3-D IONOSPHERE TOMOGRAPHY CODE AND ITS DISPLAY DEVELOPMENT
- COMPLETED REVIEW OF SES KEY ISSUES IN NPOESS A-SPEC
- COMPLETED DETAILED ANALYSIS OF SES-RECOMMENDED EDR ATTRIBUTE VALUES
- CONTINUED DETERMINATION OF PRELIMINARY SENSOR CONCEPTS AND METHODOLOGY OF SENSOR SELECTION FOR NPOESS SES SUITE AS DRIVEN BY A-SPEC
- INITIATED ANALYSIS OF BI-STATIC RADIO BEACON INSTRUMENT TO SATISFY IONOSPHERIC SCINTILLATION EDR

PRELIMINARY SES SENSORS AND EDRs (1)

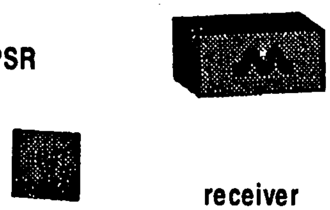
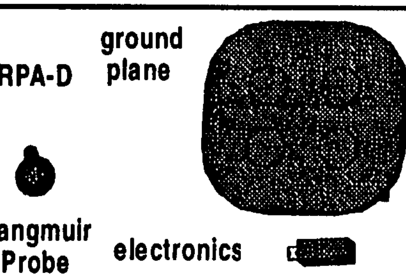
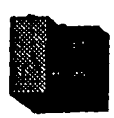
npoess

ENVIRONMENT DATA RECORD	SENSOR	COMPONENTS/ HERITAGE	ATTRIBUTES / A-SPEC IMPACTS
AURORAL & AIRGLOW IMAGERY	ABIS 	FUV NADIR IMAGER / DMSP BLOCK 5, HILAT, POLAR BEAR	• FUV REMOTE SENSING OF AURORAL AURORAL EMISSIONS • IR&X-RAY IMPLY HIGHER COMPLEXITY • DESIGN SIMILAR TO NADIS FOR COST REDUCTION
GEOMAGNETIC FIELDS	AVM 	BOOM-MOUNTED VECTOR MAGNETOMETER/ DMSP BLOCK5, MAGSAT	• PROVIDES INFORMATION ABOUT AURORAL CURRENT SYSTEMS TO SUPPORTS ELECTRODYNAMIC MODELING AND AURORAL BOUNDARY IDENTIFICATION • REQUIRES CAREFUL BOOM DESIGN
ENERGETIC PARTICLES, SOLAR PROTONS, GALACTIC COSMIC RAYS	HEPS 	UARS/PEM/NASA	• STATE-OF-ART DESIGN PROVIDES HIGH-ENERGY PARTICLE FLUXES AND SPECTRA • FLUX INTEGRATION TO YIELD TOTAL DOSE
NEUTRAL DENSITY	NADIS 	FUV LIMB-IMAGER DMSP BLOCK 5, ABIS	• FUV REMOTE SENSING OF DAYTIME NEUTRAL ATMOSPHERE EMISSIONS. • DESIGN SIMILAR TO ABIS, BUT SCANS LIMB INSTEAD OF NADIR, FOR COST REDUCTION

CONVERGENCE EFFORT MODIFICATION

PRELIMINARY SES SENSORS AND EDRs (2)

npoess

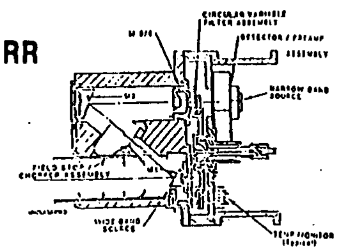
ENVIRONMENT DATA RECORD	SENSOR	COMPONENTS/ HERITAGE	ATTRIBUTES / A-SPEC IMPACTS
IONOSPHERIC ELECTRON DENSITY	GPSR  receiver 6 Antennas	GPS RECEIVER AND ANTENNA / TOPEX	• 3D GLOBAL IONOSPHERIC SPECIFICATION BY TOMOGRAPHY • PERFORMS SIMULTANEOUS GEOLOCATION
IONOSPHERIC ELECTRIC FIELDS & IN-SITU MEASUREMENTS	RPA-D ground plane  Langmuir Probe electronics	RETARDING POTENTIAL ANALYZER AND DRIFTMETER/ DMSP BLOCK 5 AND DYNAMICS EXPLORER	• STATE-OF-ART DESIGN • ADD PLASMA/RF PROBE FOR ION FLUCTUATIONS
ENERGETIC CHARGED PARTICLES	MEPS 	HEMISPHERIC ELECTROSTATIC ANALYZER / DMSP BLOCK 5 & CRRES	• STATE-OF-ART DESIGN • SIMULTANEOUS ENERGY & PITCH ANGLE DISCRIMINATION • FLUX INTEGRATION TO YIELD TOTAL ENERGY DEPOSITION

3/10/95

CONVERGENCE EFFORT MODIFICATION

PRELIMINARY SES SENSORS AND EDRs (3)

npoess

ENVIRONMENT DATA RECORD	SENSOR	COMPONENTS/ HERITAGE	ATTRIBUTES / A-SPEC IMPACTS
OPTICAL BACKGROUND	CVF/IRR 	CIRCULAR VARIABLE FILTER, INFRARED RADIOMETER, MULTIPLE DoD MISSIONS	• COOLING / COOLANT REQUIRED IF 1-29 um LIWR IS INCLUDED
IONOSPHERIC SCINTILLATIONS	BI-STATIC RADIO BEACON • RECEIVER AT MULTIPLE SURFACE SITES • TRANSMITTER AT NPOESS	WIDE-BAND / DNA	• GLOBAL SCINTILLATION PARAMETERS CAN ONLY BE MEASURED BY THIS TECHNIQUE • PROVIDES GLOBAL UPDATES TO WBMOD TYPE OF SCINTILLATION MODEL
SOLAR EUV	SOLAR EUV EXPERIMENT (SEE) / NCAR no picture available	TIMED / NASA (NOT YET FLOWN)	• TBD

3/10/95

SES NEAR-TERM PLANS

- CONTINUE DEVELOPMENT OF RECOMMENDED SES EDR ATTRIBUTES
- ASSESS VIABILITY OF EXISTING SES SENSORS TO ADDRESS/MEET NPOESS SES REQUIREMENTS
- CONTINUE CONCEPT EXPLORATION OF SES SENSORS
- WORK TO SUPPORT SUCCESSFUL SRR

npoess

C3 UPDATE

R. NELSON

3/15/95

CONVERGENCE EFFORT MODIFICATION

NPOESS C3 REQUIREMENTS

npoess

MISSION REQUIREMENTS

- DELIVER TIMELY, GIGABIT SIZE DATA RECORDS OF MULTI-SPECTRAL CLOUD DATA AND SPECIALIZED ENVIRONMENTAL DATA TO THE CENTRAL AND REGIONAL USER ELEMENTS

- UTILIZE EXISTING (AND PLANNED) AFSCN AND NOAA RESOURCES TO MAXIMUM EXTENT POSSIBLE

- MAXIMIZE THE UTILITY OF ENVIRONMENTAL DATA PRODUCTS FOR THE LOWEST C3 SEGMENT LIFE CYCLE COST.

KEY PARAMETERS

- DATA AVAILABILITY - ALL MISSION DATA SHALL BE DOWNLINKED AT LEAST ONCE PER ORBIT. AT LEAST 95% OF THE TIME, ALL MISSION DATA SHALL BE RECEIVED AT THE CENTRAL SITES WITHIN 131 MINUTES OF OBSERVATION.

- THE NPOESS MUST BE CAPABLE OF SELECTIVELY DENYING DATA DURING CONTINGENCIES OR CONFLICTS.

3/15/95

C3 RELATED REQUIREMENTS ISSUES

RI - 1: WILL RDRs WITH RADIOMETRIC CALIBRATION BE REQUIRED AT REGIONAL SITES, WHICH EDRs ARE REQUIRED?

RI - 7: PROVIDE CLARIFICATION ON REGIONAL TERMINAL INGEST & PROCESSING REQUIREMENTS. SHOULD EXISTING TERMINALS BE USED AS A BASELINE TO CONSTRAIN PHASE O STUDIES? OR, SHOULD THEY BE USED AS A BASELINE WITH IMPACTS IDENTIFIED TO MEET NPOESS REQUIREMENTS?

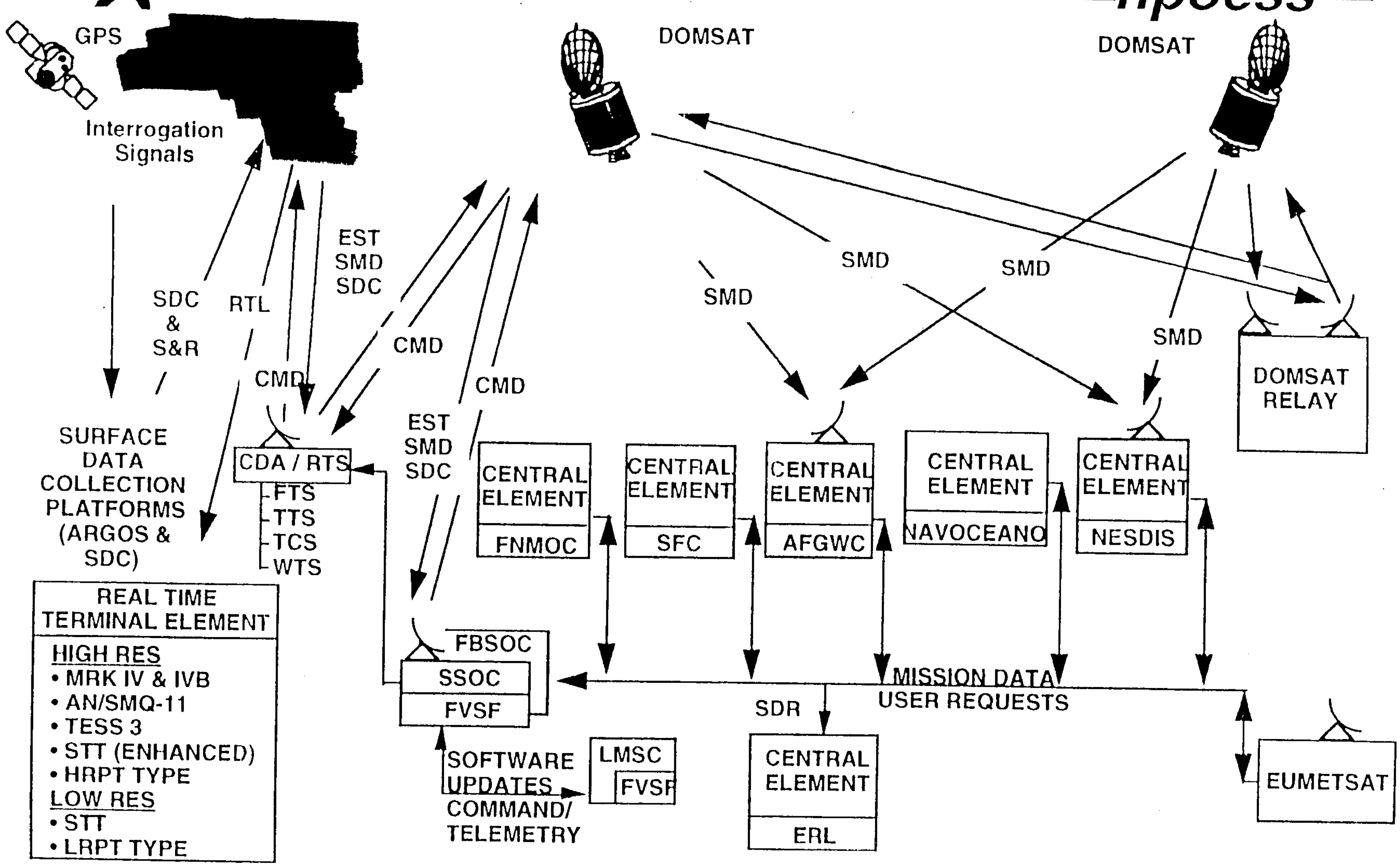
RI - 8: UPDATE C3 & IDPS GROUND RULES. SPECIFICALLY ADDRESS THE USE OF DEDICATED ASSETS AT AFSCN SITES AND WHICH SITES MAY BE CONSIDERED FOR UPGRADE. WHAT AFSCN / CDA AVAILABILITY SHOULD BE ASSUMED FOR PHASE O STUDIES?

RI - 12: WHAT ARE THE INTERFACE REQUIREMENTS FOR THE METOP SATELLITES?

CONVERGENCE EFFORT MODIFICATION

CONVERGED SYSTEM BASELINE ARCHITECTURE

npoess

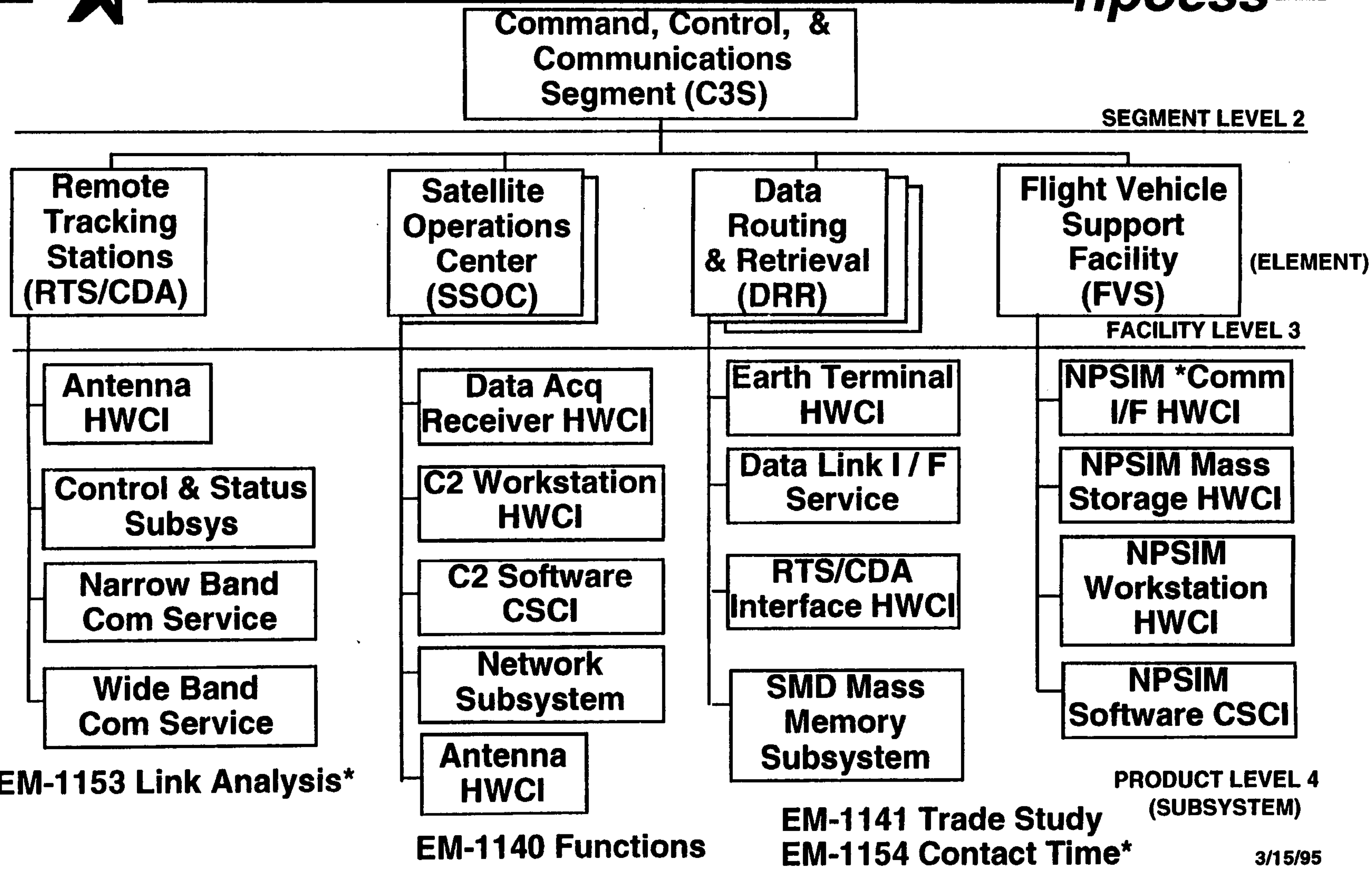


3/15/95

CONVERGENCE EFFORT MODIFICATION

CONVERGED C3 SEGMENT HIERARCHY

npoess

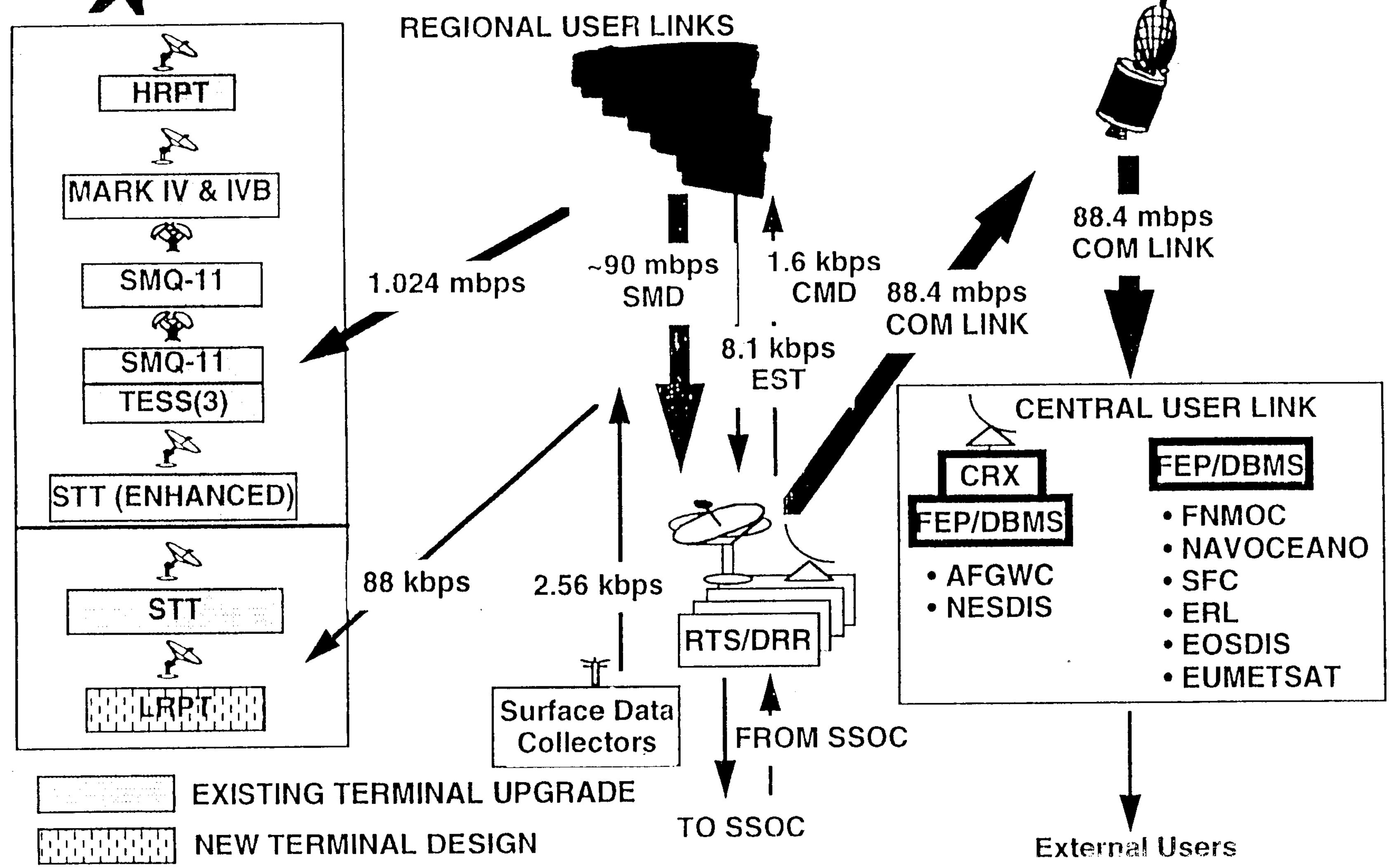


3/15/95

CONVERGENCE EFFORT MODIFICATION

CONVERGED SYSTEM LINK OVERVIEW

npoess



3/15/95

CONVERGENCE EFFORT MODIFICATION

BASELINE C3 CHARACTERISTICS

npoess

LINK TYPE	TYPE OF DATA	BAND & FREQUENCY	DATA RATE & MODULATION	COMP RATIO	RESOLUTION RESAMPLE	LINK FUNCTION
SDN	Commands, S & F	2.025 GHz	1.6 Kbps BPSK	N / A	N / A	Cmd Uplink, Store & Forward
EST	Telemetry, Special Format Data	2.20 - 2.29 GHz	8.1 Kbps	N / A	N / A	EST
SMD	All Data	X - 8.255 GHz 3 @ 100 MHz	90 Mbps SQPSK	NONE	NONE	Mission Sensor & Telemetry Data
HRPT	OMIS, MHS, AMSU-A1&A2, AIRS	S BAND 1.724 GHz	1.024 Mbps UQPSK	8:1	NONE	Realtime Data
LRPT	OMIS (3 chnl), MHS AMSU-A!&A2	UHF	88 Kbps BPSK	16 :1	4 TIMES	Realtime Data
ARGOS (SDC)	Surface Platform Data	VHF 460 - 470 MHz	2.56 Kbps	N / A	NONE	Surface Data Collection
SAR	Beacon	121.5, 243, 406.08, & 1533 MHz	0.4 & 2.4 Kbps	N / A	N / A	Search & Rescue

3/15/95

CONVERGENCE EFFORT MODIFICATION

MISSION DATA LOADING

npoess

SENSOR	DATA RATE (KBPS)	S / C O1 0530	S / C O2 2130	S / C O3 1330
AIRS	1420	X		X
AMSU-A1	2.1	X	X	X
AMSU-A2	1.1	X	X	X
ARGOS	2.56	X	X	X
IASI	1420		X	
MHS	4.2	X	X	X
MIMR	100		X	
MISS (IMAGER)	9.9	X		X
MSTRS	1.0	X		
OASIS	4500	X	X	X
SBUV/TOMS	11.0			X
SES	9. 71	X	X	X
S & R	2.0	X		X

SUMMARY	5953	6040	5963
15% OVERHEAD	893	906	894
TOTAL (KBPS)	6846	6946	6857
TOTAL / ORBIT (Gb)	41.8	42.4	41.8

3/15/95

CONVERGENCE EFFORT MODIFICATION

CONVERGED C3 DERIVED DATA REQUIREMENTS

npoess

PARAMETER	REQUIREMENT	DERIVED REQUIREMENT
On Board Sensor Data Rate		Data Rate with 15% overhead
0530 S / C	5.95 mbps	6.85 mbps
0930 S / C (EUMETSAT)	6.04 mbps	6.95 mbps
1330 S / C	5.96 mbps	6.86 mbps
Mission Data Storage	Data for 2 orbits	84.8 Gb
Mission Data Offload	Data for 1 orbit	
0530 S / C	36.3 Gb	41.8 Gb
0930 S / C (EUMETSAT)	36.9 Gb	42.4 Gb
1330 S / C	36.4 Gb	41.8 Gb
SMD Downlink	X-Band	8.255 GHz (TBR)
Data Rate (8.0 min contact without gaps)	Data for 1 orbit	90 mbps
Downlink Sites	4 CDA / RTS	FTS, WTS, TTS, TCS
Timeliness	Downlink 1 per orbit period	Data delivered and processed in 130 min.
Data Format	TBD	CCSDS

3/15/95

CONVERGENCE EFFORT MODIFICATION

KEY PARAMETER LIST

npoess

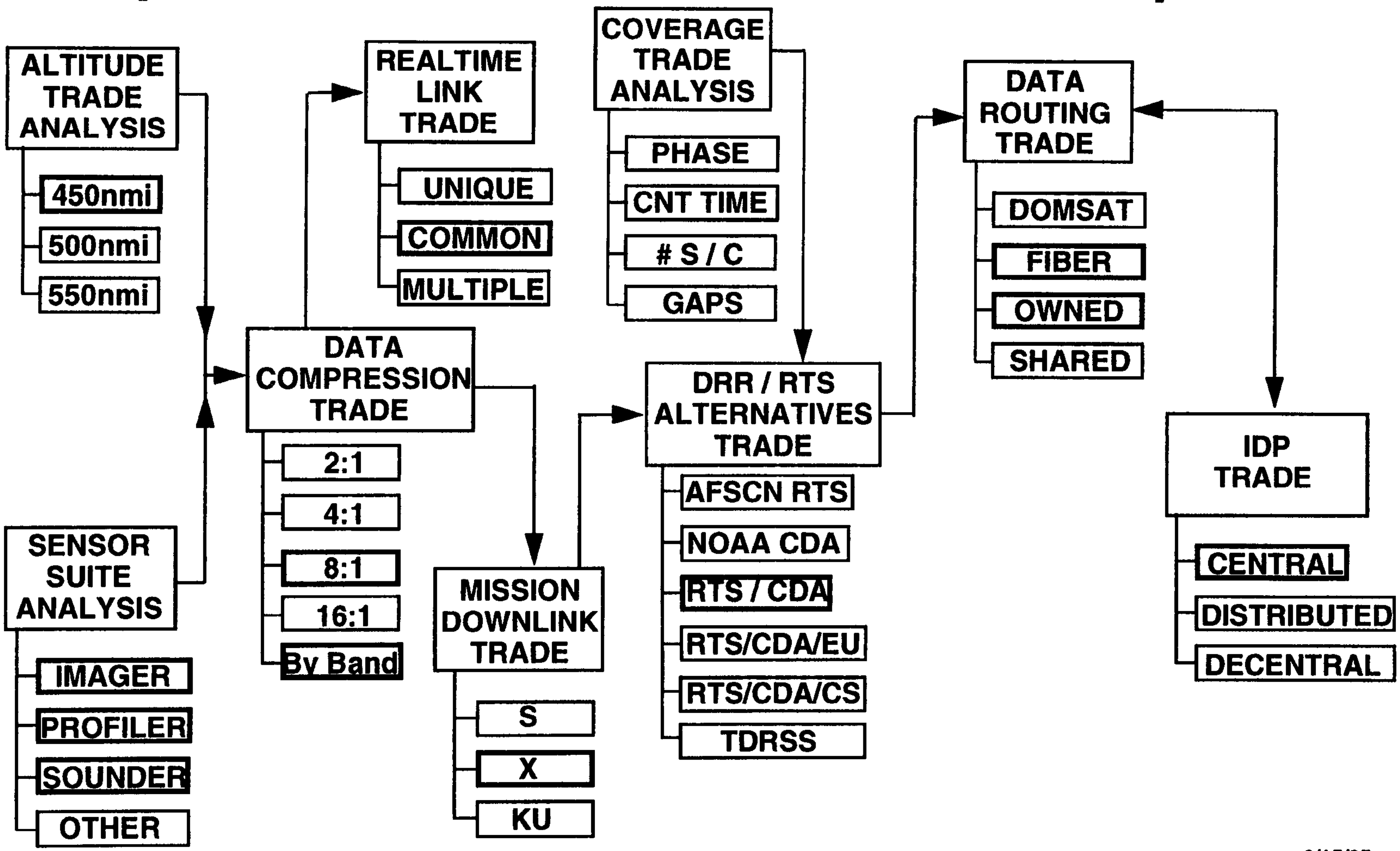
KEY PARAMETER	SOLUTION	SENSITIVITY
DATA AVAILABILITY (TIMELINESS)	DUAL EDR PROCESSING SITES (ONLY) AFGWC & NESDIS	NO. OF CENTRAL LINKS MAJOR COST DRIVER
DATA ACCESS	SELECTIVE DENIAL	
DRIVING PARAMETER	**SOLUTION**	**SENSITIVITY**
MISSION DATA RATE	AT LEAST 90 MBPS X-BAND FOR 6.9 MBPS	OASIS RESOLUTION & CONTACT TIME DRIVES RATE
REGIONAL TERMINALS	HIGH RES - (1.024 MBPS TBR) LOW RES - (88 KBPS TBR)	COMPATIBILITY, COMPRESSION, & RESOLUTION DRIVE RATE
DATA COMPRESSION	NO SMD COMPRESSION, 8 :1 HRPT, 16:1 LRPT	ADDITIONAL RESOLUTION RESAMPLE FOR LRPT
CDA / RTS CONFIGURATION	FAIRBANKS, WALLOPS, THULE OAKHANGER (TBR)	HIGH LAT STATIONS INCREASE CONTACT TIME
CONTACT TIME	8 MIN. (MIN.)	INCREASE CONTACT TIME LOWER DATA RATE

3/15/95

CONVERGENCE EFFORT MODIFICATION

C^3S- IDPS TRADE FLOW

npoess



3/15/95

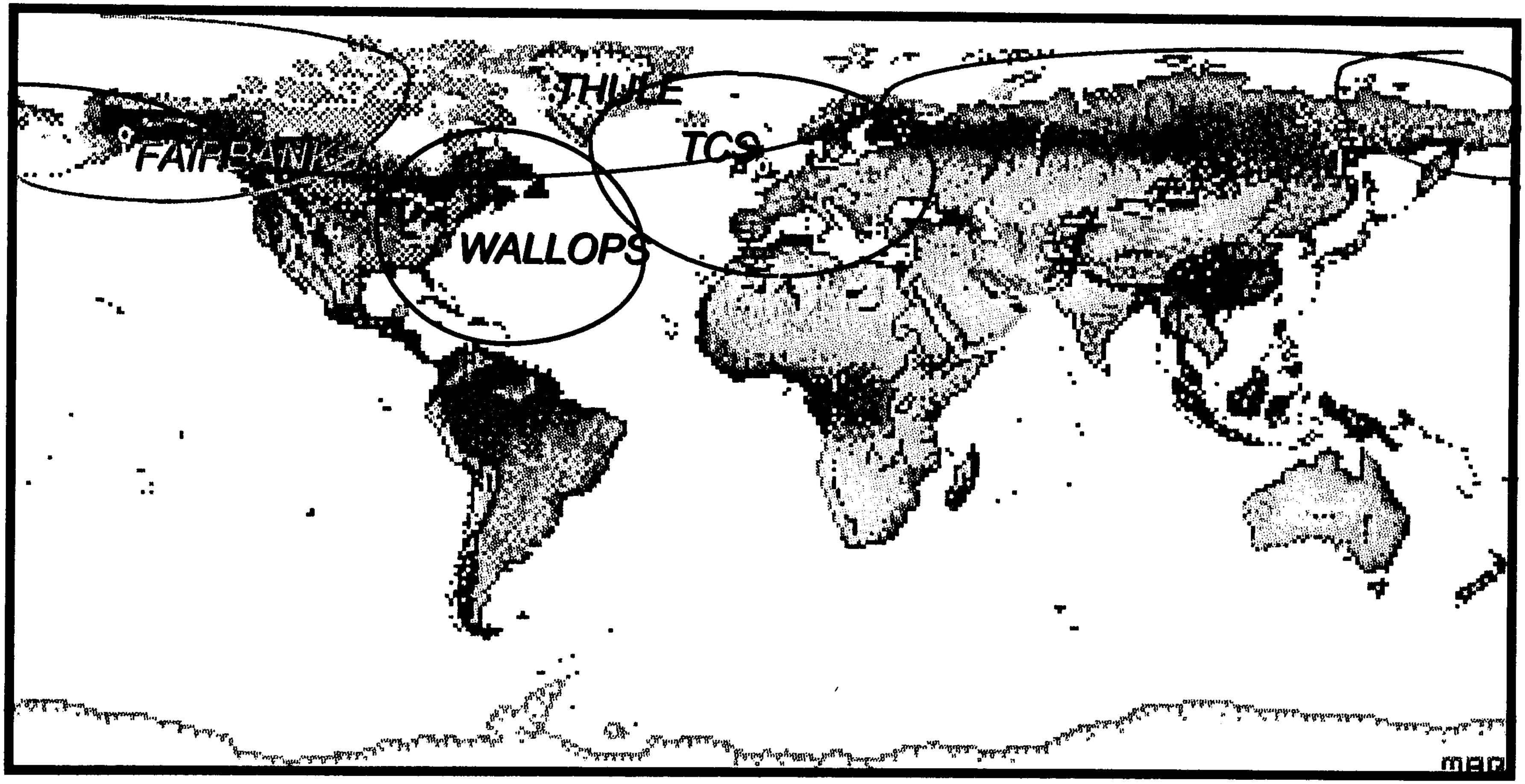
DRR TRADE STUDY ASSUMPTIONS

npoess

- THREE SATELLITES NEED TO BE BE SUPPORTED SIMULTANEOUSLY
- SP NET ADEQUATE TO ROUTE PROCESSED DATA TO CENTRAL USER SITES (UPGRADE TO DS-3 PLANNED)
- COMPARATIVE COMM LINK AND O&M COSTS ARE FOR TEN YEAR PERIOD
- O & M COSTS ARE FOR RTS/CDA MANNING WITH MINIMUM STAFF
- COST OF HIGH DATA RATE LINKS WILL REMAIN CONSTANT OVER THE 10 YEARS LIFE CYCLE
- COSTS INCLUDE TRANSPONDER AND FO CABLE LEASE AND DATA DATA TERMINALS (USE EXISTING TERMINALS WHERE APPLICABLE)
- NESDIS & AFGWC ASSUMED AS CENTRALIZED LOCATIONS FOR DATA PROCESSING IN CENTRALIZED CONFIGURATIONS (AS PER NAV/AF)

BASELINE RTS / CDA CONFIGURATION

npoess



3/15/95

EXTENDED COVERAGE STUDY SUMMARY

- ICAP RUNS MADE WITH BASELINE CONSTELLATION UTILIZING 4 PRIMARY CDA'S (FTS,TCS,TTS & WI) WITH ACTUAL OBSCURA
- 113 PASSES/SC IN 8 DAYS; 339 FOR THE CONSTELLATION
- NETWORK OF 3 CDA'S (FTS, TCS & TTS) PROVIDE 100% COVERAGE OF ALL PASS; ONE PASS LESS THAN 8 MINS NET
- WI SEES 32 PASSES/SC; 16 COMMON WITH FTS - 16 WITH TTS
- THERE ARE 2O SINGLE STATION PASSES/SC WITH NO BACKUP PROVIDED BY ANY OF THE OTHER PRIMARY CDA'S

CONVERGENCE EFFORT MODIFICATION

NETWORK AUGMENTATION FOR SINGLE STATION BACKUP

npoess

PASS NO	PRIMARY SITE	HTS	KTS	NHS	VT
6	FTS	X	X		
12	TTS		X		X
20	FTS	X	X		X
22	TCS		$\boxed{X}$		
26	TTS		X		X
36	TCS		$\boxed{X}$		
40	TTS		X		X
48	FTS		X		X
49	FTS	X	X		
50	TCS		$\boxed{X}$		
52	TTS		X	X	
63	FTS	X	X		
66	TTS		$\boxed{X}$		
76	FTS				X
77	FTS	X	X		
80	TTS		$\boxed{X}$		
91	FTS	X	X		
93	TCS		$\boxed{X}$		
105	FTS	X	X		X
107	TCS		X		X
TOTAL 20		7	19	1	8

$\boxed{}$ = ONLY VISIBLE @ KTS

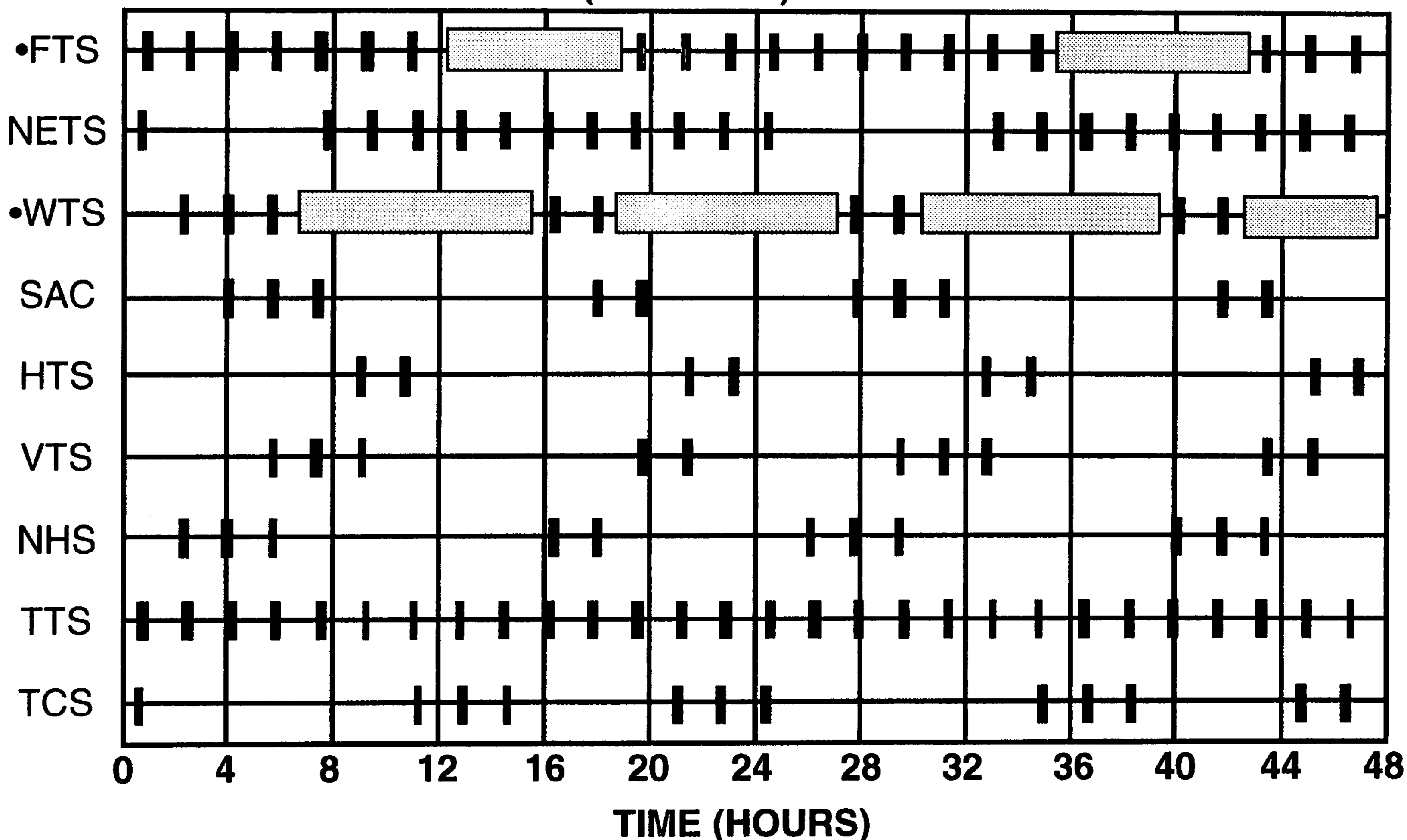
3/15/95

CONVERGENCE EFFORT MODIFICATION

RTS / CDA VISIBILITY COVERAGE

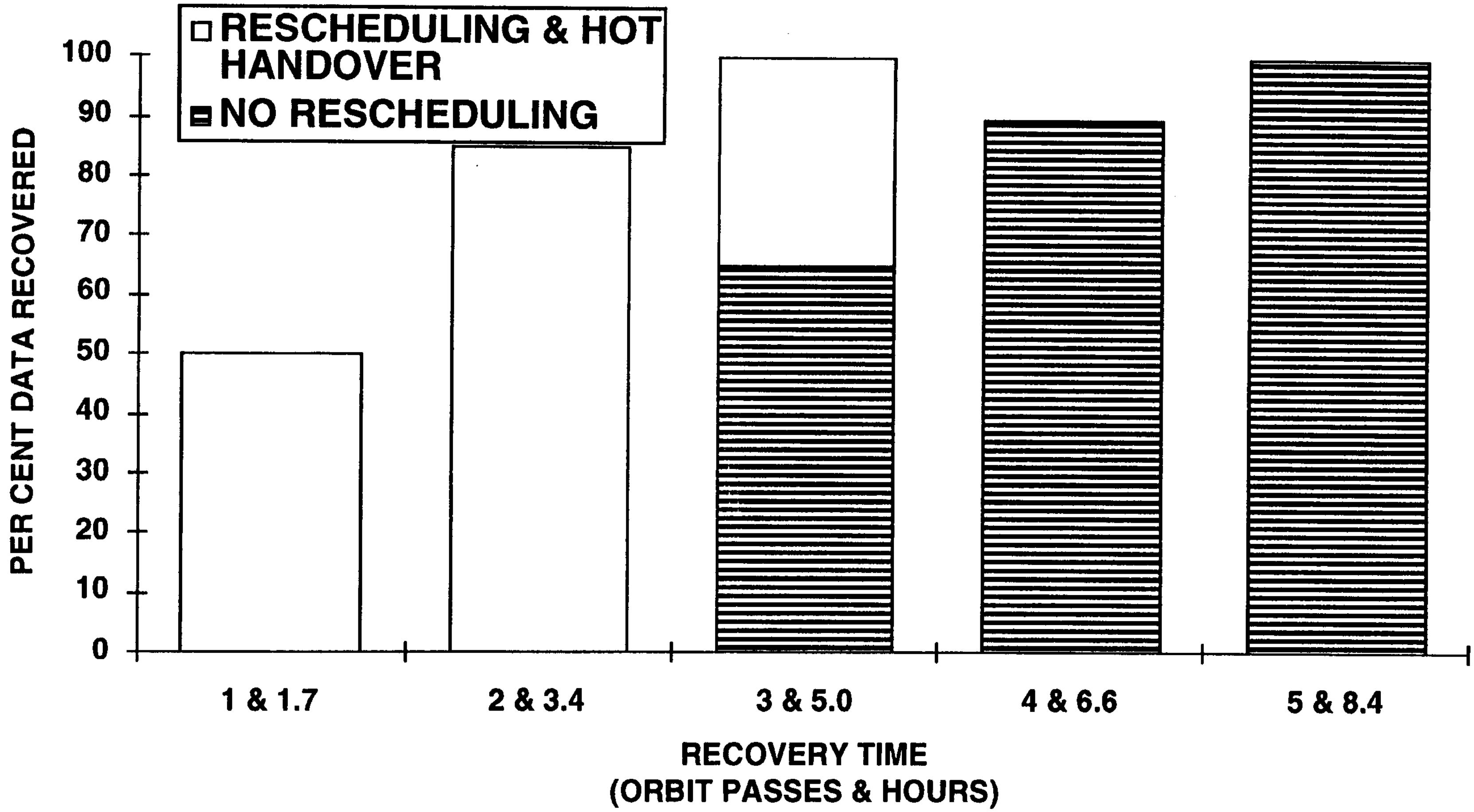
npoess

(48 HOURS)



3/15/95

RECOVERY FROM MISSED PASS

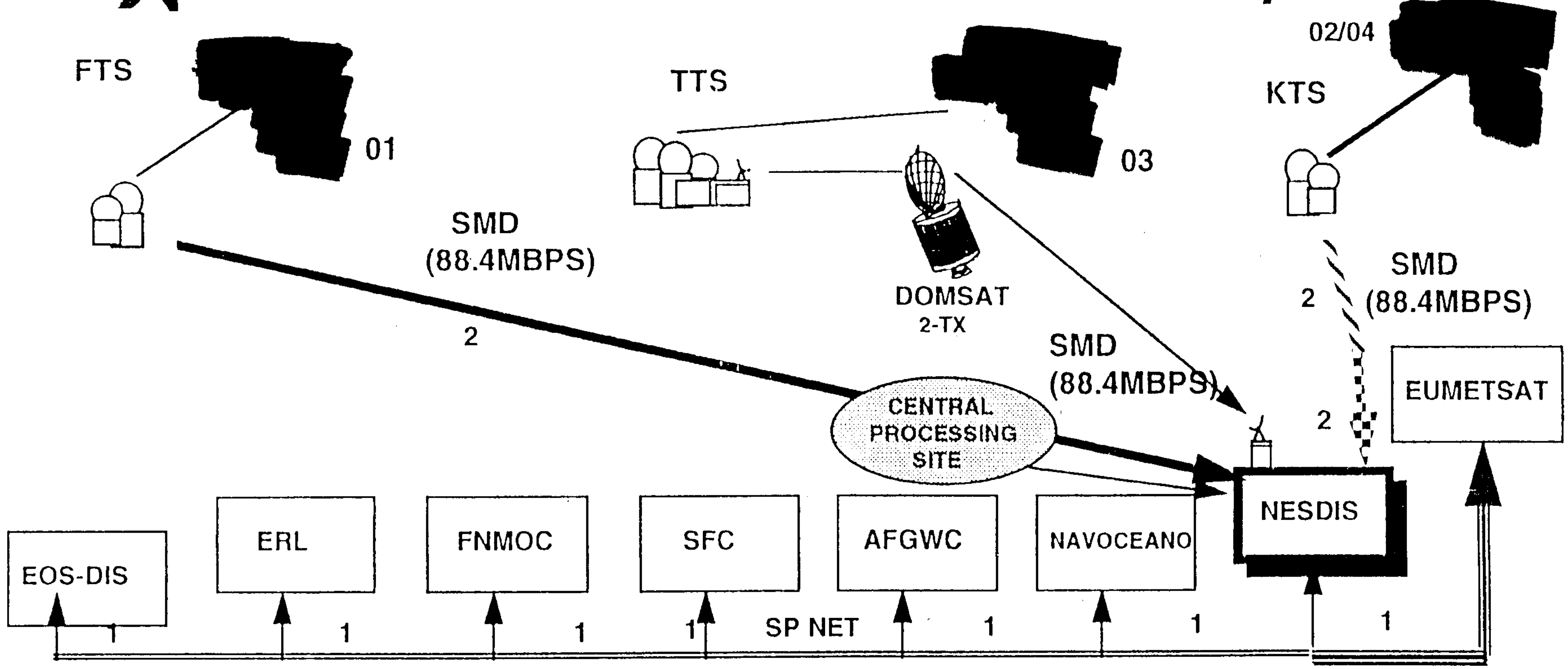


3/15/95

CONVERGENCE EFFORT MODIFICATION

CONFIG A: NORTHERN RTS'S, FO COMS CENTRALIZED PROCESSING

npoess



COMMUNICATION LINK REQUIREMENTS

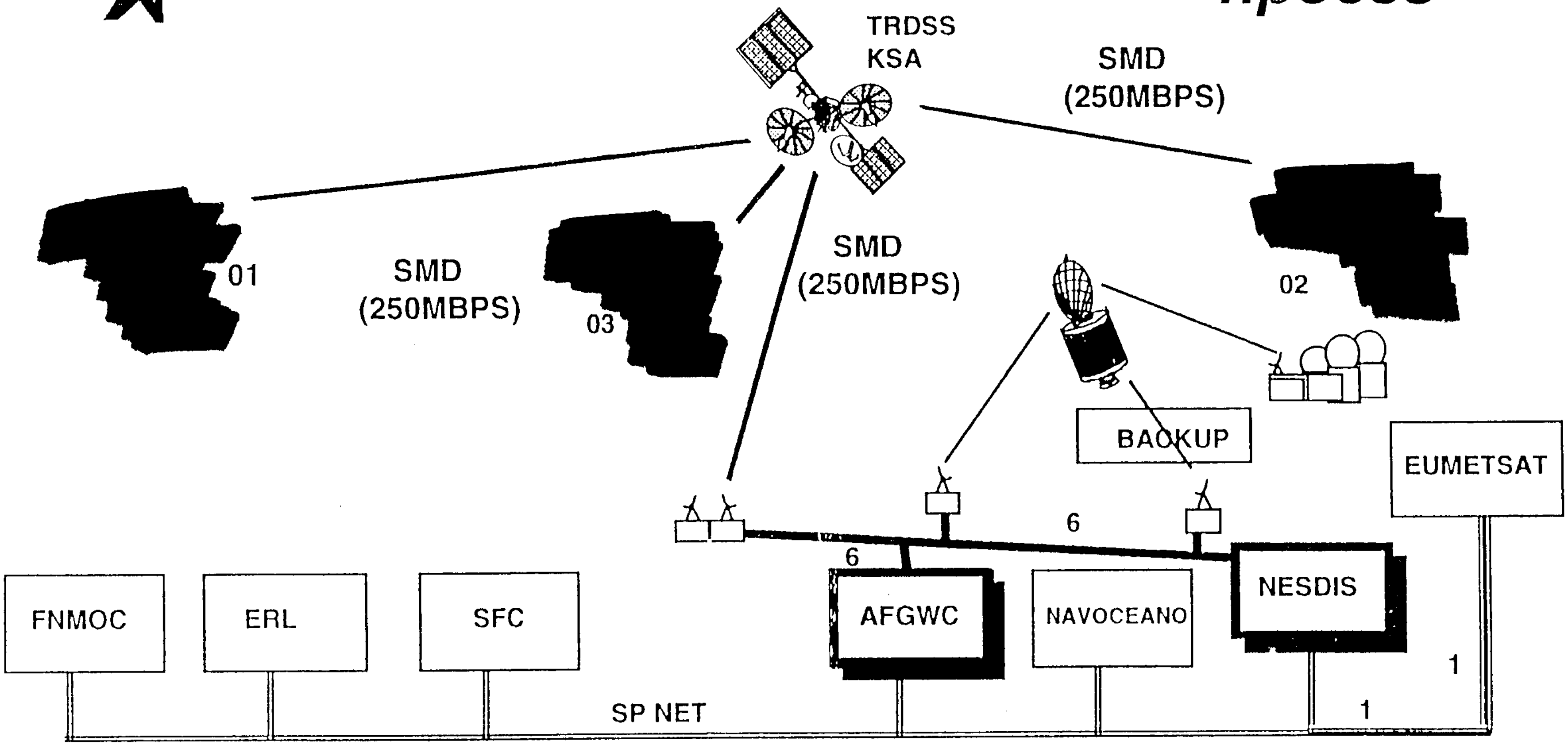
TYPE	CONUS FO (DS3)	OCONUS FO (DS3)	TRANSOCEAN FO (DS3)	DOMSAT TX/ TER	LO RATE FO (DS1)	LO RATE TRNSOCN (DS1)
QUANTITY	2	2	2	2 2	6	1

DS3 LINK RATE 44.2 MBPS DOMSAT C- BAND TRANSPONDER, SUPPORTS 1 DS3 DS1 LINK RATE 1.5 MBPS

CONVERGENCE EFFORT MODIFICATION

CONFIG 1: TDRSS, CENTRALIZED PROCESSING

npoess



COMMUNICATION LINK REQUIREMENTS

TYPE	CONUS FO (DS3)	OCONUS FO (DS3)	TRANSOCEAN FO (DS3)	DOMSAT TX/ TER	LO RATE FO (DS1)	LO RATE TRNSOCN (DS1)
QUANTITY	12	0	0	2 2	1	1

DS3 LINK RATE 44.2 MBPS DOMSAT C- BAND TRANSPONDER, SUPPORTS 1 DS3 DS1 LINK RATE 1.5 MBPS

CONVERGENCE EFFORT MODIFICATION

INTERIM DRR TRADE SUMMARY

npoess

Configuration	A	B	C	D	E	F	G	H
SITES COMM PROCESSING	N RTS FO CNTR	N RTS FO DISTR	N RTS DMSAT CNTR	N RTS DMSAT DISTR	R &CE FO DECNTR	R &CE FO DISTR	R &CE DMSAT DECNTR	R &CE DMSAT DISTR
• Timeliness	OK	OK	OK	OK	TBD	TBD	TBD	TBD
• Max Data Rate • Max Data Rate (MBPS)	88.4	88.4	88.4	88.4	TBD	TBD	TBD	TBD
• Coverage	OK	OK	OK	OK	OK	OK	OK	OK
• Stations to Mod/Add	1	1	1	1	4	4	4	4
• No. Stations to Man	3	3	3	3	5	5	5	5
• No. of DRR Links	20	48	18	23	12	46	13	17
• Comparative Costs								
- RTS Mods	.06	.06	.06	.06	.16	.16	.16	.16
- Comm Links/Term	.60	1.04	.74	.82	.36	1.05	.43	.56
- O & M	.04	.04	.07	.12	.09	.09	.11	.15
Total	.70	1.14	.87	1.00	.61	1.30	.70	.87
	3	7	5	6	1	8	2	4

3/15/95

TDRSS COST SUMMARY

npoess

OPTIONS	WITH $120/MIN TDRSS CHARGE	WITHOUT TDRSS CHARGE*
CENTRALIZED	.25	.12
CENTRALIZED WITH BACKUP	.48	.35
DISTRIBUTED WITH DOMSAT DIST	.48	.35
DISTRIBUTED WITH FO	.50	.42
DISTRIBUTED WITH FO DIST WITH BACKUP	.57	.44

* THE NASA ADMINISTRATOR HAS THE OPTION OF WAIVING THE STANDARD TDRSS CHARGE TO PROGRAMS OF NATIONAL IMPORTANCE

MEETING SCHEDULED WITH NASA FOR UPDATE OF TDRSS CAPABILITIES

3/15/95

CONVERGENCE EFFORT MODIFICATION

DRR CRITICAL ISSUES

npoess

- HIGH DATA RATE (DS-3) LINKS ARE THE SEGMENT COST DRIVER
  - REDUCE TIMELINESS AND / OR SMD DATA RATE - CUT COST TO 50%

- INFRASTRUCTURE IMPACT COST
  - NAV/AF AGREEMENTS ALLOW FEWER CENTRAL PROCESSING SITES
    - WHAT IS STATUS OF AGREEMENT IN CONTEXT OF NPOESS?
  - SPN UPGRADES REDUCE NEED FOR REDUNDANT LINKS
    - WHAT ARE UPGRADE PLANS?
  - EOSDIS I / F
    - WHAT IS THE RELATIONSHIP PLANNED?

- OPTIMIZE SELECTION OF CDA / RTS SITES
  - NORTHERN LATITUDE SITES TO PROVIDED INCREASED CONTACT TIME

- OPS CONCEPT & EUMETSAT I / F
  - EUMETSAT DATA NEEDED FOR 4 HR REFRESH -
    WHAT ARE THE AGREEMENTS TO ASSURE DATA AVAILABILITY ?

COMMAND AND CONTROL

DAVE EMANUEL

COTS UTILIZATION IN C2 SYSTEMS

- SOFTWARE ENGINEERING PROCESS HAS BEEN DEVELOPED WHEREIN COTS IS NOW A MAJOR CONSIDERATION IN IMPLEMENTATION OF C&C SYSTEMS

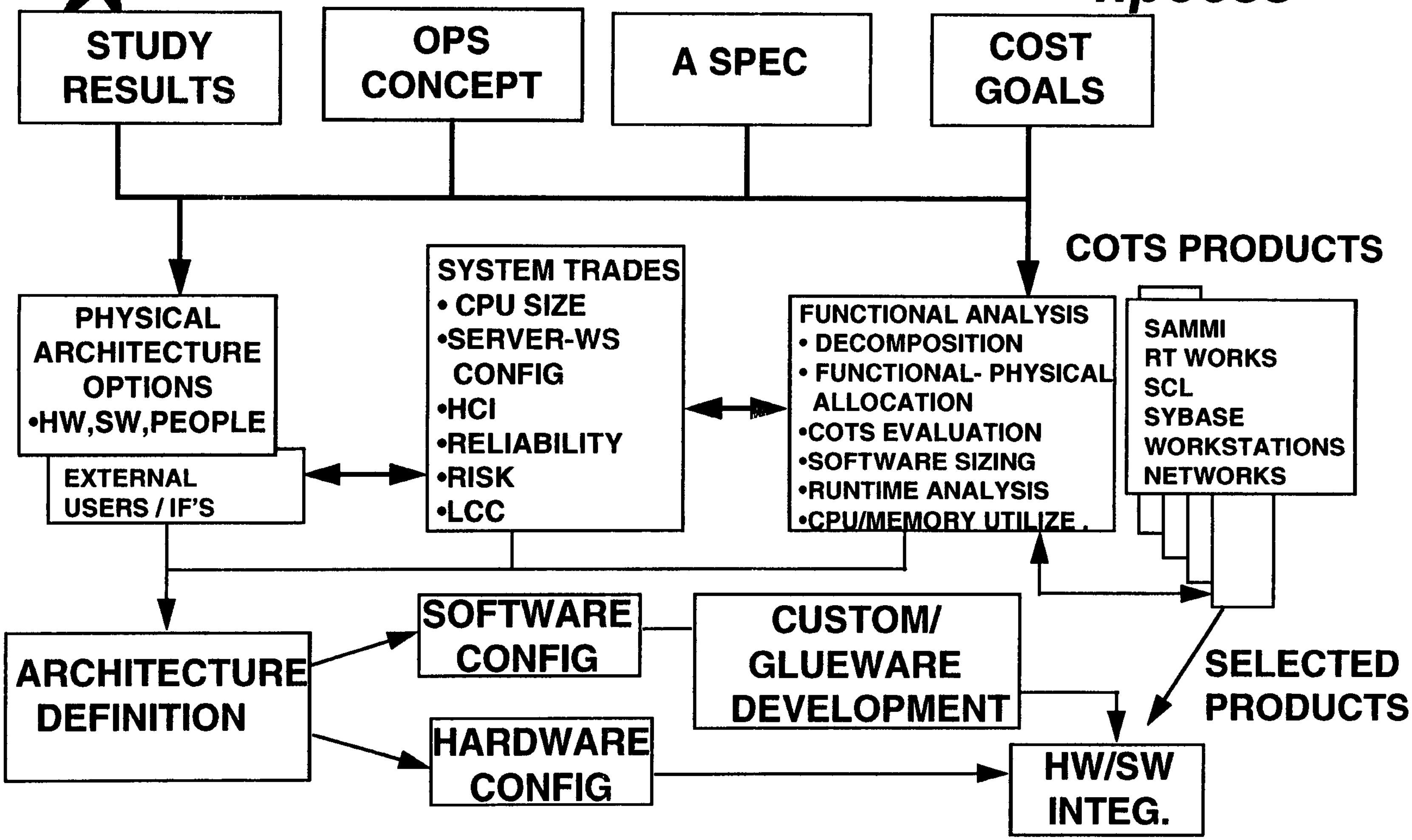
- NUMEROUS MATURE PRODUCTS ARE AVAILABLE; MORE CONTINUOUSLY DEVELOPED/IMPROVED

- SELECTION PROCESS INCLUDES:

  - GROUPING OF FUNCTIONALLY RELATED REQUIREMENTS
  - CONTROL OF FUNCTIONALLY COMPLEX ENTITIES
  - MINIMIZATION OF INTERFACE COMPLEXITY AND COUPLING
  - ALIGNMENT WITH HARDWARE AND SOFTWARE ARCHITECTURE

COTS C2 SYSTEM INTEGRATION APPROACH

npoess



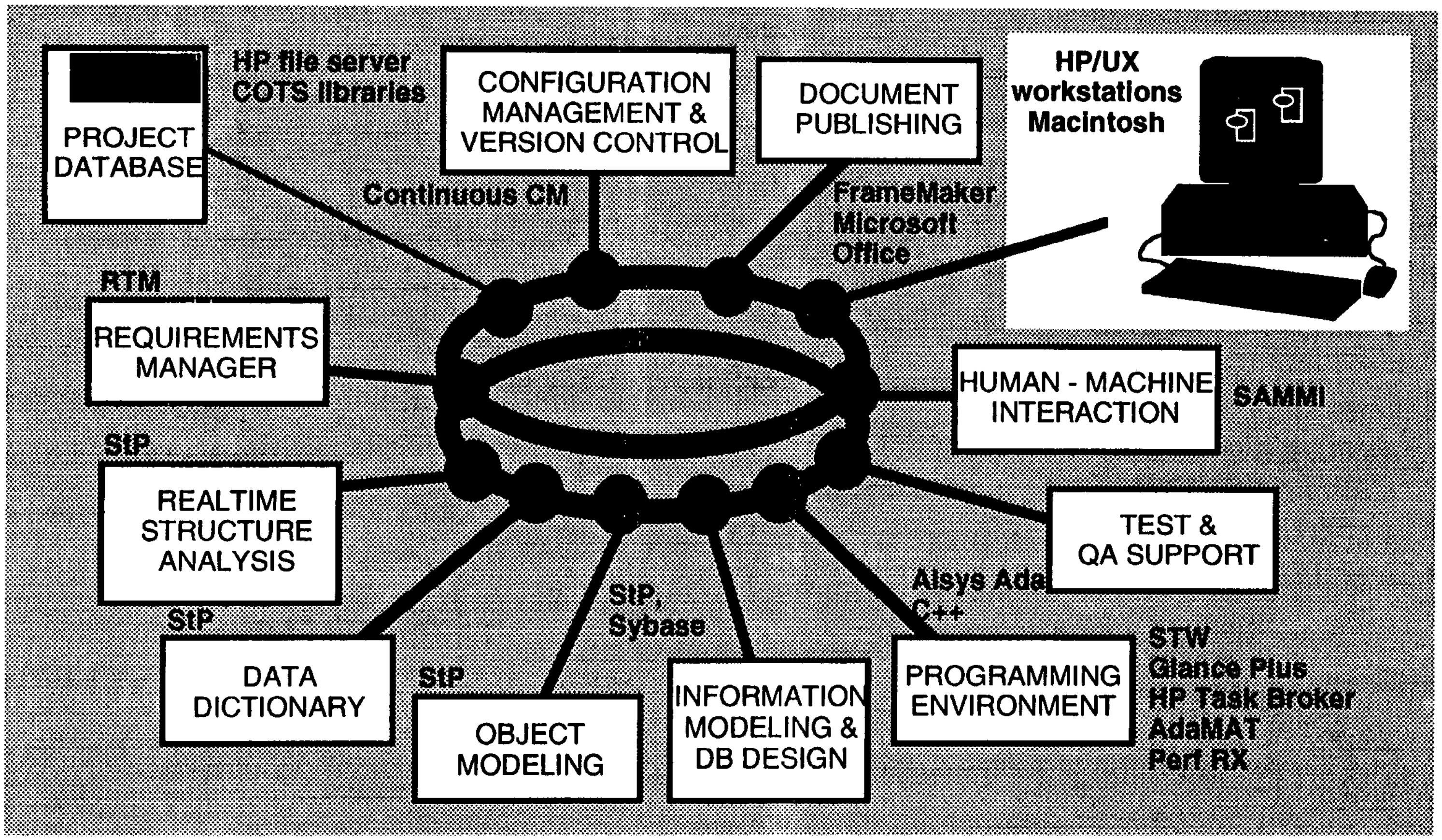
3/15/95

CONVERGENCE EFFORT MODIFICATION

SOFTWARE ENGINEERING ENVIRONMENT USES COMPATIBLE COTS PRODUCTS

npoess

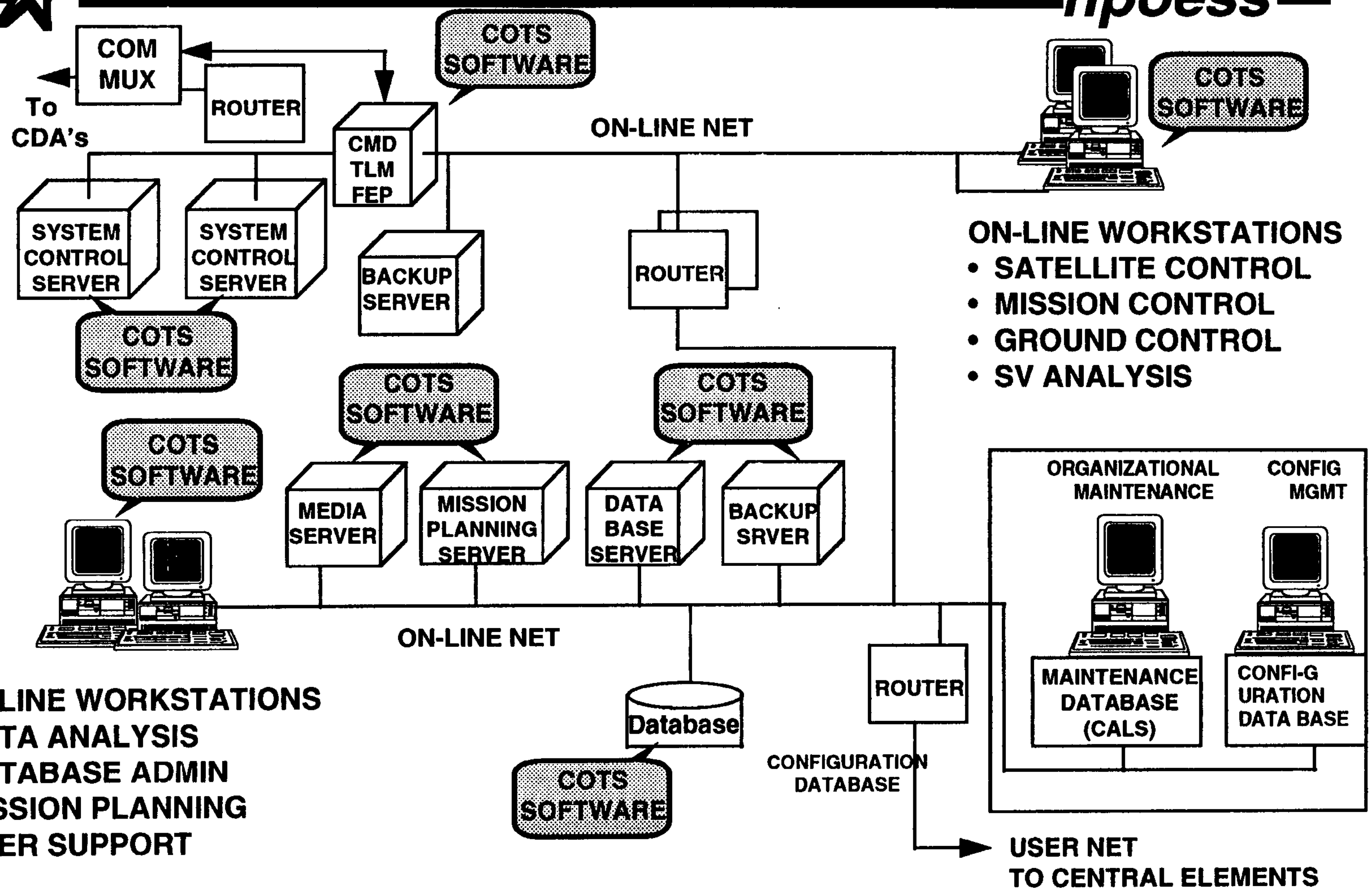
C2 DEVELOPMENT



3/15/95

TYPICAL COMMAND & CONTROL ARCHITECTURE

npoess



ON-LINE WORKSTATIONS
- SATELLITE CONTROL
- MISSION CONTROL
- GROUND CONTROL
- SV ANALYSIS

OFF-LINE WORKSTATIONS
- DATA ANALYSIS
- DATABASE ADMIN
- MISSION PLANNING
- USER SUPPORT

Note: All Hardware is COTS

3/15/95

C2 SYSTEM FEATURES

- OPEN SYSTEMS APPROACH SUPPORTED BY POSIX COMPLIANT OPERATING SYSTEM
  - BUNDLED WITH TCP/IP NETWORK PROTOCOL, MOTIF INTERFACE FOR DISPLAYS,NETWORK FILE SYSTEM AND FTP FOR STANDARD FILE TRANSFER
- DISTRIBUTED FUNCTIONS ON SERVERS AND WORKSTATIONS
  - ALLOWS NEW FUNCTIONS/UPGRADES WITHOUT AFFECTING OTHER FUNCTIONS
- DISTRIBUTED NETWORK DESIGN ISOLATES FUNCTIONS FOR PERFORMANCE AND PROVIDES ALL FUNCTIONS TO COMMUNICATE
- NETWORK BRIDGES ISOLATE REAL-TIME FUNCTIONS AND INSURE OFF-LINE PERFORMANCE SURGES DO NOT AFFECT REAL-TIME OPERATION
- DATABASE INTERFACE ALLOWS EASY ACCESS TO DATA BY ALL COTS PRODUCTS

CONVERGENCE EFFORT MODIFICATION

C2 FUNCTIONS DECOMPOSED AND MAPPED TO COTS PRODUCTS

npoess

COMMAND & CONTROL SYSTEM

SYSTEM STATUS
- SYNC / DECOM TELEMETRY
- ON-LINE STATUS
- DIAGNOSTIC RESULTS
- STATUS LIMIT CHECKS
- SV TLM
- CDA / CC CENTER

SYSTEM CONTROL
- INITIALIZATION
- FORMAT COMMANDS
- ECHO CHECK CMDS
- DIAGNOSTIC CONTROL FAILOVER
- ENCRYPTION / REKEY CONTROL
- DATA DENIAL CONTROL

ORBIT DETERMINATION (LEO ONLY)
- ORBIT UPDATE
- PROPAGATE EPHEMERIS
- ALMANAC PARAMETERS
- TIME CORRELATE

SPACECRAFT & INSTRUMENT SUPPORT
- GENERATE BUS CMDS
- GENERATE INST CMDS
- PROCESS UPLOADS

HUMAN COMPUTER INTERFACE
- OPERATOR I / F
- AUTOMATED SUPPORT
- ON-LINE DOCUMENTATION
- CONTEXT SENSITIVE HELP

MISSION PLANNING & RESOURCE SCHEDULING
- SV VISIBILITY PROFILES
- ALLOCATE RTS / CDA RESRCS
- ALLOCATE COMM RESRCS
- GENERATE / MODIFY SCHDS

CONSTELLATION MANAGEMENT
- ORBIT ADJUST PLANNING
- ORBIT PLAN
- INST COVERAGE

DATA MANAGEMENT
- DATA STORAGE & RETRIEVAL
- DATA ANALYSIS
- FILE TRANSFER
- USER FILE TRANSFER

NETWORK & COMMUNICATIONS
- EXTERNAL COMM CONTROL
- WAN
- LAN

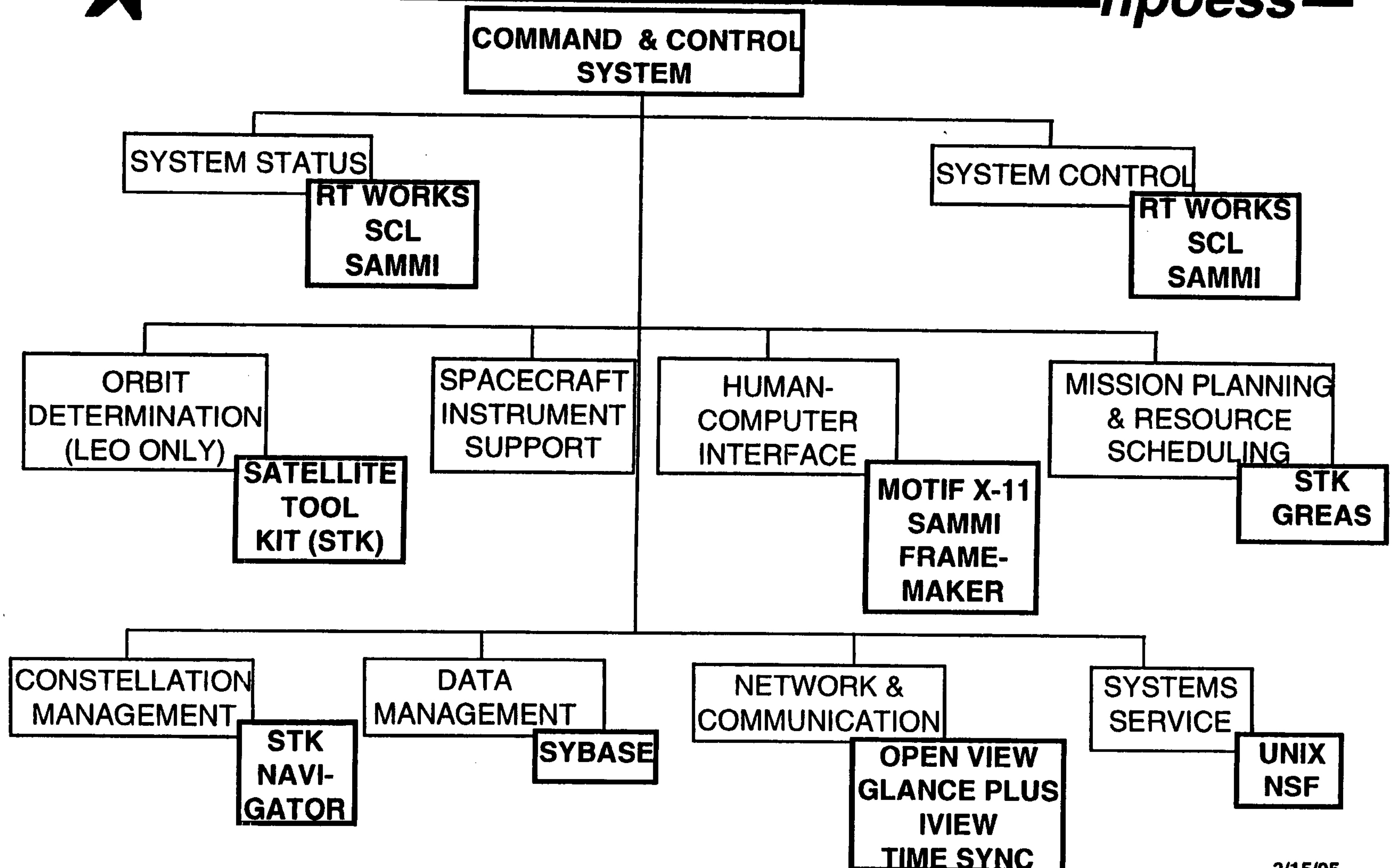
SYSTEM SERVICES
- OPERATING SYSTEM
- HARDWARE DIAGNOSTIC
- HARDWARE MONITORING

3/15/95

CONVERGENCE EFFORT MODIFICATION

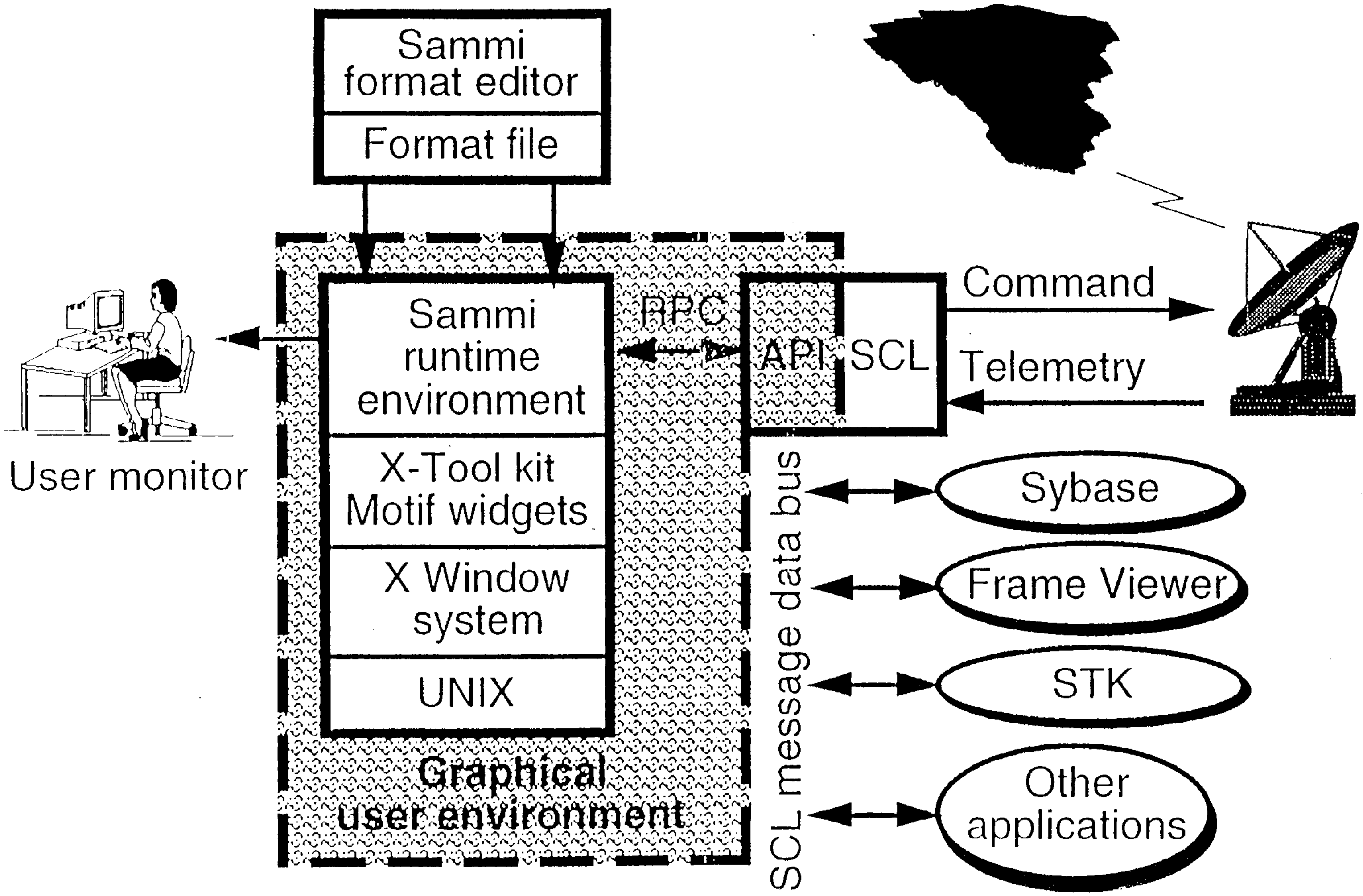
C2 COTS PRODUCTS CANDIDATES

npoess



3/15/95

MULTIPLE COTS SW PACKAGES USED IN HCI DEVELOPMENT



3/15/95

CONVERGENCE EFFORT MODIFICATION

EXPERIENCE WITH COTS C2 PRODUCTS

npoess

COTS products	Heritage	Features	Benefits
Sammi	• Used 4 years in Lockheed HCI rapid prototyping and usability lab • Currently used at AF tracking stations for Titan IV inertial upper stage • Used at NASA mission control center for Space Shuttle and Space Station • Selected for Space Station Freedom • Selected for Canadian Automated Air Transportation System	• X-Window/Motif based GUI • Client/server architecture • Comes bundled with SCL • Comes with API to Sybase • Dynamic display object library • API library ready to use • Alarm management capability • Report generation capability • Multiscreen support • Security limits access and designates authorized users • Displays are modified without impacting mission applications • New displays are immediately usable; no code generation • Application development and prototyping are quick and easy	• Reduces training/maintenance costs • Access to multiple applications • Facilitates COTS integration • Facilitates COTS integration • Reduces development cost • Facilitates COTS integration • Reduces development cost • Reduces development cost • Reduces development cost • Ensures system integrity • Reduces software maintenance cost • Reduces development cost • Reduces design and development cost
Spacecraft Command Language (SCL)	• Used on Lockheed satellite test ID program • Used on Clementine Space Probe • Selected for NASA autonomous rendezvous and docking satellites • Selected for ROMPS GAS Space Shuttle Experiment • Used on JPL Pluto	• Comes bundled with Sammi • Realtime telemetry acquisition and commanding • Integrated Expert System • Automatic event response • Operator advisory capability • Automated data filtering • Realtime data archival • Easy to use natural syntax language for scripts and rules • Message data bus facilitates communication	• Facilitates COTS integration • Enhances mission operations • Enhances automated support • Reduces development cost • Reduces development cost • Reduces development cost • Reduces development cost • Facilitates expert system development • Simplifies COSE data interface
FrameViewer (document viewing)	• Used by Lockheed proposal group • Used by Claris Corp. • Used by American Airlines • Used by Cadence Design Systems • Used by RollsRoyce	• Hypertext navigation • Includes text, graphics, and equations • Immediate access to documentation modifications • Same file used for document creation and distribution • Distribution documents are view-only • Multimedia support	• Move directly to desired information • Provides complete operator aids • Provides new information quickly • Saves time and disk space • Security prevents unauthorized changes • Expandability for future growth
FrameMaker (document creation)	• Used by Lockheed proposal group • Used by Claris Corp. • Used by American Airlines • Used by Cadence Design Systems • Used by RollsRoyce	• Easy to learn and easy to use • Automatically inserts hypertext links • API link to other applications • Import data from other applications	• Reduces development costs • Reduces development costs • Facilitates COTS integration • Facilitates transfer of legacy documentation
Sybase	• Used by many Lockheed programs including CRSS	• API to Sammi available • Relational database • Open client/server architecture	• Facilitates COTS integration • Minimizes resources required • Delivers data quickly and efficiently across network

SGLS vs USB / STDN PERFORMANCE SUMMARY

npoess

UPLINK SERVICE	SGLS**	USB/STDN**
• FREQUENCY BAND	1.76-1.84 GHZ	2.025 - 2.120 GHZ
• COMMAND		
• MOD TYPE	TERNARY FSK/AM/PM	PSK ON 16 MHZ SUBCARRIER
• RATE	0-2KBPS	0-8 KBPS
• INTERFACE	SERIAL DATA STREAM	4800-BIT NASCOM BLOCKS
• RANGING *	1 MBPS PRN CODE/PM ON CARRIER	MULTI-TONES ON 27.7 SUBCARRIER
POWER	0-10 KW	16W-20 KW
DOWNLINK SERVICE		
• FREQUENCY BAND	2..2-2..3 GHZ	2.2-2.3 GHZ
•TELEMETRY		
• MOD TYPE	PCM/PSK	PCM/PSK
• SUB CARRIER FREQ	1.024 OR 1.7 MHZ	1 KHZ TO 2 MHZ
• DATA RATE	8 BPS - 256 KBPS	1 BPS - 5 MBPS
• RANGING ACCURACY *	11 FEET	1.0 METER
• RANGE DATA PROCESSING*	AFSCN/USSC	NASA GSFC

* NOT IN LMSC BASELINE NPOESS SYSTEM ** WORLD WIDE SUPPORT AVAILABLE

3/15/95

CONVERGENCE EFFORT MODIFICATION

SGLS vs USB / STDN FOR NPOESS

npoess

- BOTH SYSTEMS PROVEN AND MATURE; MEET NPOESS REQUIREMENTS
- COTS FLIGHT & GROUND HARDWARE AVAILABLE; COST EQUIVALENT
- COST ADVANTAGE WOULD BE THE LESSER NUMBER OF MODIFIED CDA'S/RTS'S FOR THE APPROACH TAKEN:
- STDN PROVIDES HIGHER UPLINK RATE WHICH COULD SUPPORT ADDITIONAL SERVICES

APPROACH	STATION MODS REQUIRED					ADDITIONAL BACKUP	
	FTS	WI	TCS	TTS	TOTAL BASELINE	HTS	VTS
SGLS	Y	Y	N	N	2	N	N
USB/STDN	N	N	Y	Y	2	Y	Y

Note: Cost to modify each station approximately [redacted]

3/15/95

REGIONAL TERMINAL COMPATIBILITY

npoess

REGIONAL DATA RATE 2.7 TO 3.8 GB PER PASS

SPEC REQUIREMENT	EXISTING CAPABILITY	REQ DATA RATE	IMPACT
HIGH RESOLUTION TERMINAL	HRPT 0.66 MBPS HIGH RES TACTICAL 0.66 & 1.024 MBPS	1 TO 3.5 MBPS	3.5 MBPS MEETS REQ WITH 2:1 COMPRESSION NEW DESIGN IMPACTS ALL EXISTING SETS 1 MBPS SET IMPACTS COMPRESSION LEVEL & DATA RESOLUTION
LOW RESOLUTION TERMINAL	APT ~ 60 KBPS STT TACTICAL 88 KBPS TO 1.024 MBPS	60 KBPS TO 1 MBPS	APT SET TO BE REPLACED STT IN DEFINITION DESIGN DEPENDENT ON USE, RESOLUTION, & COMPRESSION

REALTIME LINK ISSUES SUMMARY

- ALL REGIONAL TERMINAL DESIGNS ARE DEPENDENT ON:

  PRODUCT UTILIZATION
  - RESOLUTION REQUIRED: LESS THAN .65 AT EDGE OF SCAN?
  - NUMBER OF CHANNELS: 3 OR 4 OASIS CHANNELS?
  - RADIOMETRIC ACCURACY: LOSSY COMPRESSION

- NEW DESIGN OR UPGRADE
  - COST OF NEW TERMINALS VS UPGRADE COST
  - ANSMQ-11/ TESS & MKIVB HAVE DUAL CAPABILITY
  - LOGISTICS SUPPORT COSTS CAN BE SUBSTANTIAL

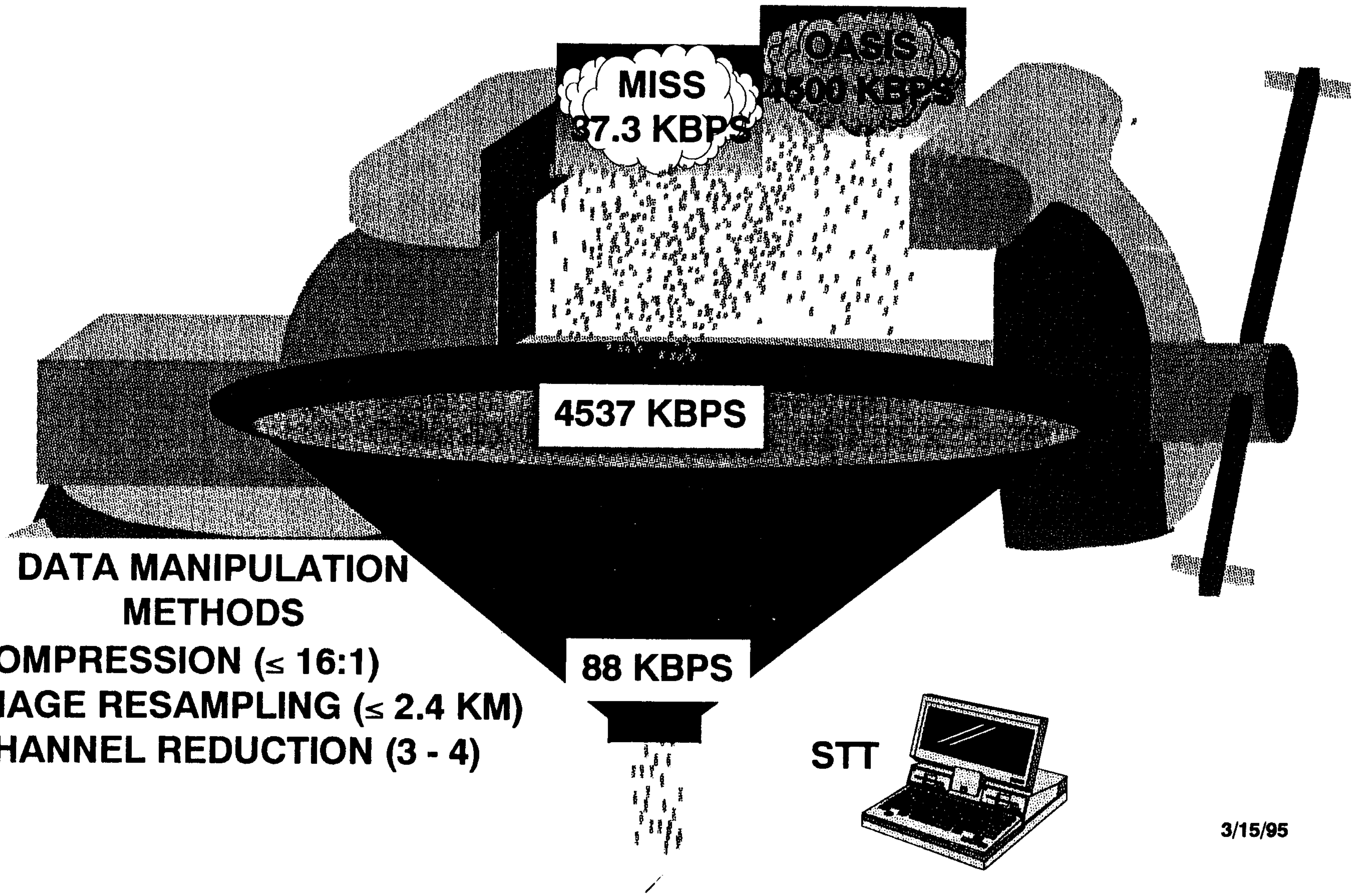
- EVALUATE COMPRESSION OF MICROWAVE AND IR SOUNDER DATA

- INTERNET TRADE MAY YIELD SIGNIFICANT BENEFITS

CONVERGENCE EFFORT MODIFICATION

LOW RESOLUTION REGIONAL TERMINAL DATA RATE ACCOMMODATION

npoess



DATA MANIPULATION METHODS

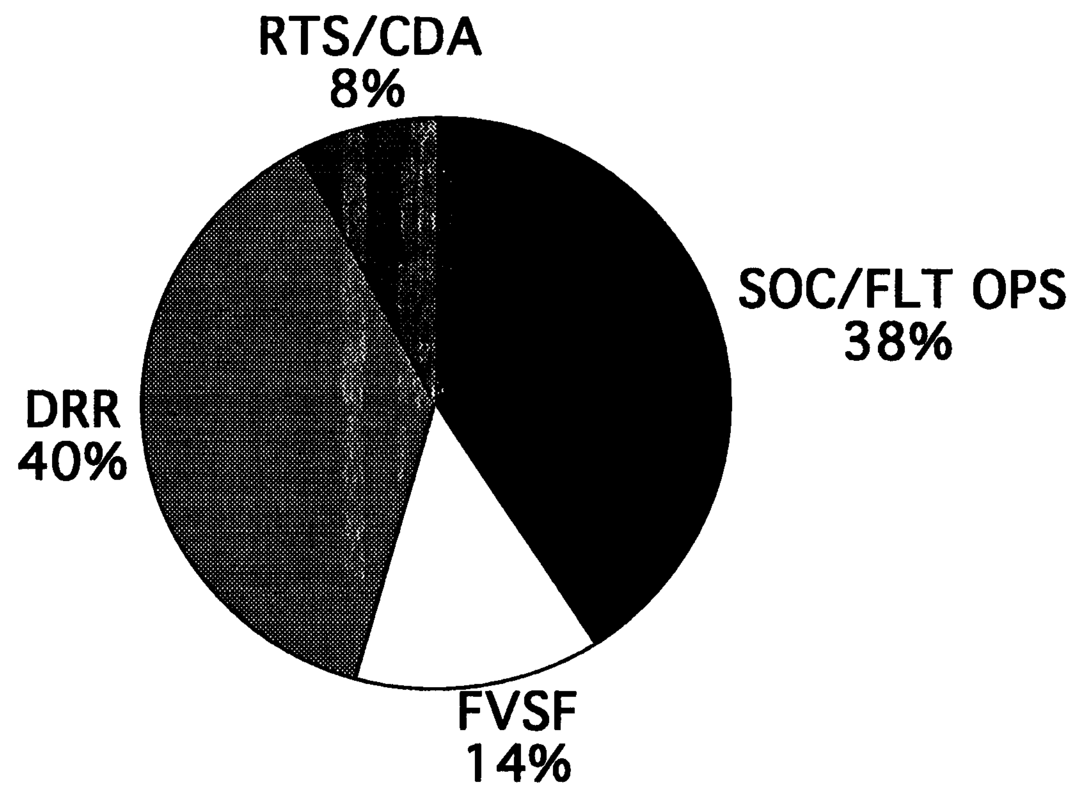
- COMPRESSION (≤ 16:1)
- IMAGE RESAMPLING (≤ 2.4 KM)
- CHANNEL REDUCTION (3 - 4)

3/15/95

CONVERGENCE EFFORT MODIFICATION

COST OVERVIEW

npoess



3/15/95

DRR & CDA / RTS EQUIPMENT PHSL - 1

npoess

ITEM NAME OR MODEL NUMBER	MAKE or BUY	FAIRBANKS	WALLOPS	THULE	OAK HANGER	TOTAL
ANTENNA SUBSYSTEM						
ANTENNA DISH	B	1	1	1	1	2 / 4
DUPLEX FEED AND CONE	B	1	1	1	1	2 / 4
RECEIVER ANTENNA FEED & CONE	B	1	1	1	1	2 / 4
ANTENNA DRIVE	B	1	1	1	1	2 / 4
SERVO CONTROL	B	1	1	1	1	2 / 4
ANTENNA CONTROL UNIT	B	1	1	1	1	2 / 4
ANTENNA /TRANSMITTER I / F	B	1	1	1	1	4
ANTENNA /RECEIVER I / F	B	1	1	1	1	4
PEDESTAL/PLATFORM	B	1	1	1	1	2 / 4
TRANSMISSION SUBSYSTEM						
HIGH GAIN AMPLIFIER	B	1	1	1	1	4
FREQUENCY UP CONVERTER	B	1	1	1	1	4
POWER COMBINER	B	1	1	1	1	4
MODULATOR	B	1	1	1	1	4

6/15/95

CONVERGENCE EFFORT MODIFICATION

DRR & CDA / RTS EQUIPMENT PHSL - 2

npoess

ITEM NAME OR MODEL NUMBER TRANSMISSION SUBSYS (COND'T)	MAKE or BUY	FAIRBANKS	WALLOPS	THULE	OAK HANGER	TOTAL
MASS MEMORY UNIT	B	1	1	1	1	4
ENCRYPTOR	B	TBD	TBD	TBD	TBD	TBD
RECEIVER SUBSYSTEM						
FREQUENCY DOWN CONVERTER	B	1	1	1	1	4
LOW NOISE AMPLIFIER	B	1	1	1	1	4
TRACKING RECEIVER	B	1	1	1	1	2 / 4
TRACKING PRE-AMP	B	1	1	1	1	2 / 4
TRACKING DOWN CONVERTER	B	1	1	1	1	2 / 4
POSITION TRANSDUCERS	B	1	1	1	1	2 / 4
POSITION READOUT	B	1	1	1	1	2 / 4
POWER DIVIDER	B	1	1	1	1	2 / 4
DOMSAT LEASE						
TRANSPONDER CHANNEL (44 mbps)	L	2	2	2	2	8

3/15/95

CONVERGENCE EFFORT MODIFICATION

SOC EQUIPMENT
DATA PROCESSING ONLY

npoess

1.15.2.1.2.1	DATA PROCESSING EQUIPMENT			E	E	B
1.15.2.1.2.1.1	Time/Frequency System	Loral	#9100	E	E	B
1.15.2.1.2.1.2	Data Acquisition Chassis	Loral	PRO 0550	E	E	B
1.15.2.1.2.1.2.1	FPP	Loral	FPP %%%	E	E	B
1.15.2.1.2.1.2.2	Command FPP	Loral	FPP 515	E	E	B
1.15.2.1.2.1.2.3	Bit Sync	Loral		E	E	B
1.15.2.1.2.1.2.4	Multiformat Decom	Loral	MFD 530	E	E	B
1.15.2.1.2.1.2.5	Simulator	Loral	MDS 540	E	E	B
1.15.2.1.2.1.2.6	IRIG Time Code	Loral	ETC 534	E	E	B
1.15.2.1.2.1.2.7	Bridge	Loral	BRG 550	E	E	B
1.15.2.1.2.1.2.8	Parallel I/O	Loral	PIO 575	E	E	B
1.15.2.1.2.1.2.9	Digital I/O	Loral		E	E	B
1.15.2.1.2.1.3	Wideband Recorder	Datatape	DTR-6	E	E	B
1.15.2.1.2.1.3.1	Wideband Recorder Tape	Datatape		E	E	B
1.15.2.1.2.1.3.2	Recorder Rackmount Option	Datatape		E	E	B

CONVERGENCE EFFORT MODIFICATION

SRR TO - GO TASKS

npoess

- C3 SEGMENT INPUT TO SYSTEM SPEC

- UPDATE & AUGMENT END - TO - END SEGMENT ANALYSIS
  - KEY & DERIVED REQUIREMENTS
  - SYSTEM TIMELINESS
  - CONTACT TIME VARIATION
  - RTS / CDA & DRR KTA TRADE REVISION
  - LINK ANALYSIS

- FINALIZE C3 CONCEPT

- OPS CONCEPT REVIEW AND RECOMMENDATIONS
  - SCENARIO OF DATA ROUTING AND DELIVERY
  - COMMAND & CONTROL

- LOGISTICS PLANNING

- PROGRAM RISK ANALYSIS

- LCC COST ANALYSIS

3/15/95

npoess

INTERFACE DATA PROCESSOR SEGMENT UPDATE

PHILLIP TOPPING AND GREG LOGAN

3/15/95

IDPS BASELINE REVIEW

- **IDPS REQUIREMENT ISSUES**
  - #54, #57
- **CENTRAL ELEMENT BASELINE**
  - PROCESSING REQUIREMENTS
  - EDR STORAGE REQUIREMENTS
- **FIELD ELEMENT BASELINE**
  - DOWNLINK ALTERNATIVES
  - PROCESSING REQUIREMENTS
  - EDR STORAGE REQUIREMENTS
  - EDR REQUIREMENTS
  - MODIFICATION TO MARK IVB

REQUIREMENT ISSUE #54 (CONT)

- ISSUE: DO ALL CENTRALS HAVE TO PROCESS ALL EDRS WITHIN 20 MINUTE REQUIREMENT?
- GOVERNMENT RESPONSE: NO, COMPLETE RESPONSE IN WORK
- IMPLICATIONS:
  - ALL BASELINE EDRS ARE PROCESSED WITHIN 20 MINUTES EDRS
  - EDRS NOT TIME CRITICAL CAN BE PROCESSED AFTER THE 20 MINUTE DEADLINE E.G. SAR AND CLIMATIC TYPE EDRS
- IMPACT: MINIMAL
  - VIS/IR IMAGER PROCESSING TO PRODUCE TIME CRITICAL EDRS, CLOUD IMAGERY AND CLOUD PRODUCTS, ARE PROCESSING DRIVERS
  - ESTIMATE PROCESSING LOAD WILL BE VIRTUALLY UNCHANGED

REQUIREMENT ISSUE #57

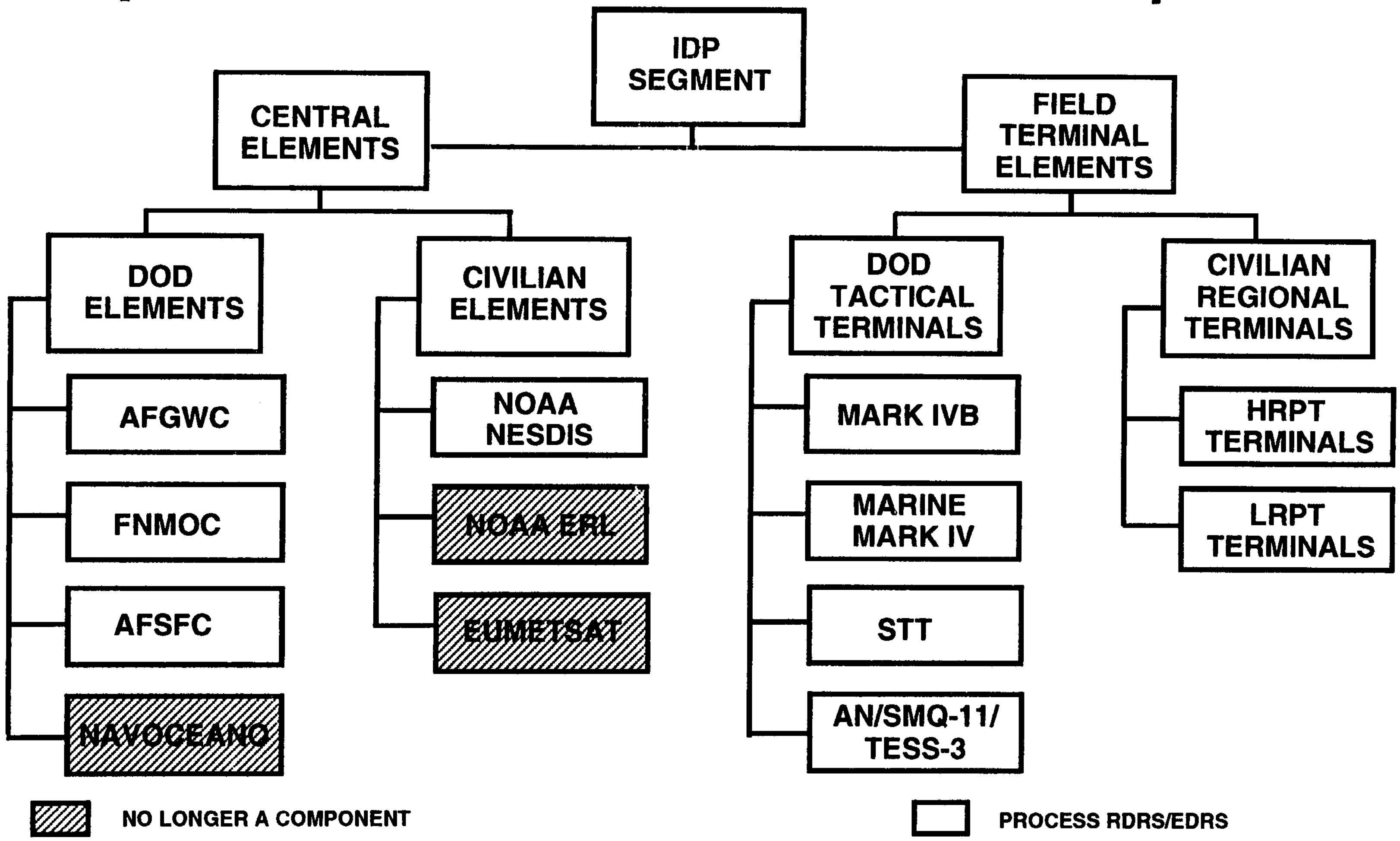
npoess

- ISSUE: WHICH SITES ARE CONSIDERED CENTRALS?
- GOVERNMENT RESPONSE: AFGWC, FNMOC, AFSFC, AND NESDIS
- IMPLICATIONS:
  - NAVOCEANO IS NOT A CENTRAL SITE
  - NPOESS CONTRACTOR WILL DEVELOP IDPS ONLY FOR AFGWC, FNMOC, AFSFC, AND NESDIS
  - INCLUDING NESDIS IMPLIES FULL EDR PROCESSING AT NESDIS
- IMPACT:
  - NAVOCEANO NOT INCLUDED IN NPOESS UPGRADE EVEN THOUGH NAVOCEANO IS A CURRENT RECEIVER AND PROCESSOR OF POES
  - NPOESS INTERFACE TO NAVOCEANO MUST BE SPECIFIED E.G. EDRS FROM CENTRAL X OVER NETWORK Y

CONVERGENCE EFFORT MODIFICATION

IDP SEGMENT RECOMMENDED BASELINE

npoess



3/15/95

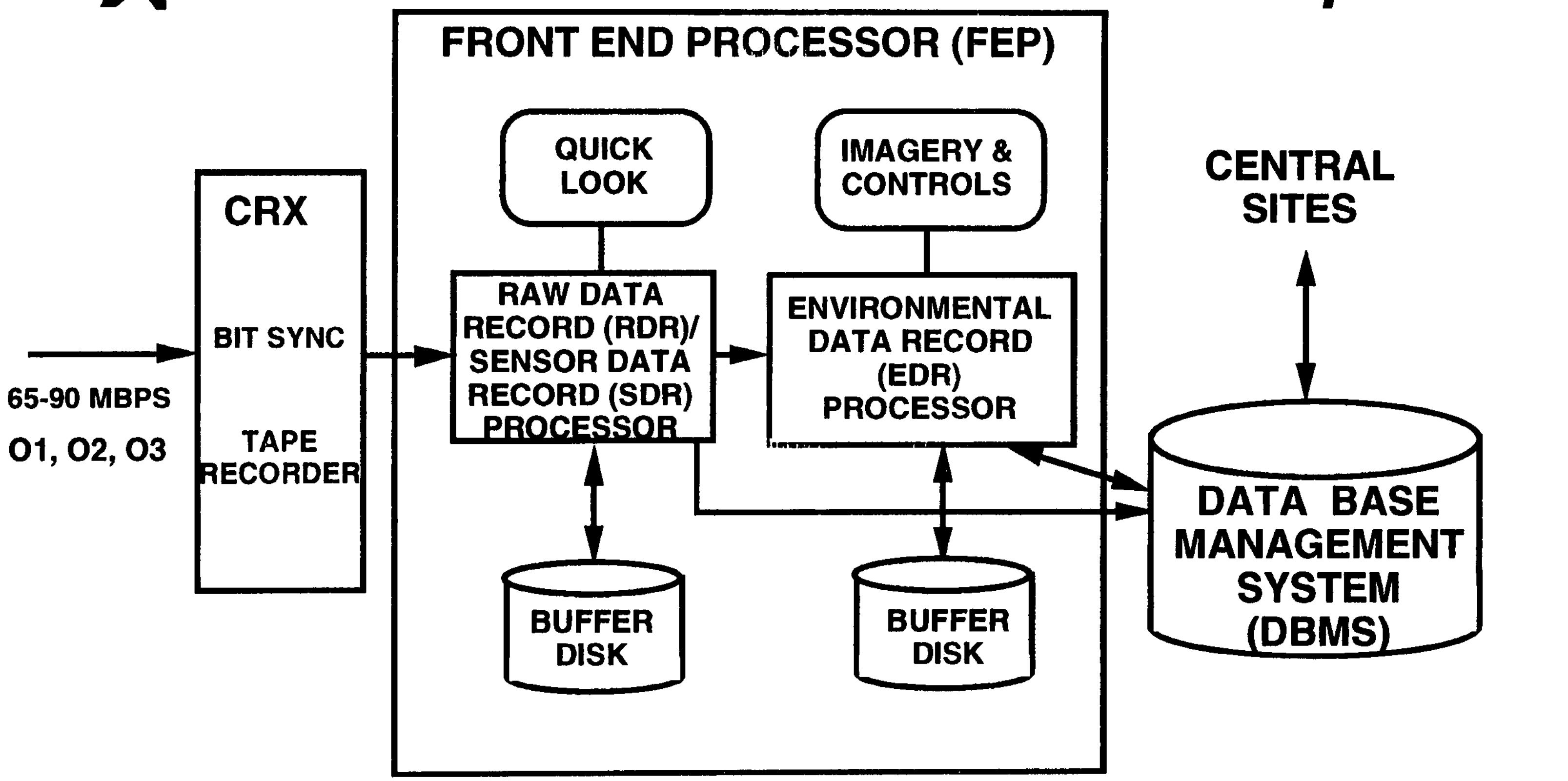
IDPS CENTRAL ELEMENT BASELINE

- ASSUMPTIONS:
  - TIME CRITICAL EDRS TO MUST BE PROCESSED WITHIN 20 MINUTES OF RECEIPT OF LAST DATA DOWNLINKED
  - LESS TIME CRITICAL EDRS SUCH AS CLIMATIC TYPE EDRS AND SEA ICE FROM SAR DATA CAN BE PROCESSED AFTER THE 20 MINUTE DEADLINE (BUT WITHIN AN HOUR OF RECEIVING LAST DATA DOWNLINKED)
  - CENTRAL CITES ARE SIZED TO PROCESS ALL RDRs INTO EDRs (I.E. HAVE HARDWARE AND SOFTWARE CAPABILITY)

CONVERGENCE EFFORT MODIFICATION

IDPS CENTRAL SITE ARCHITECTURE

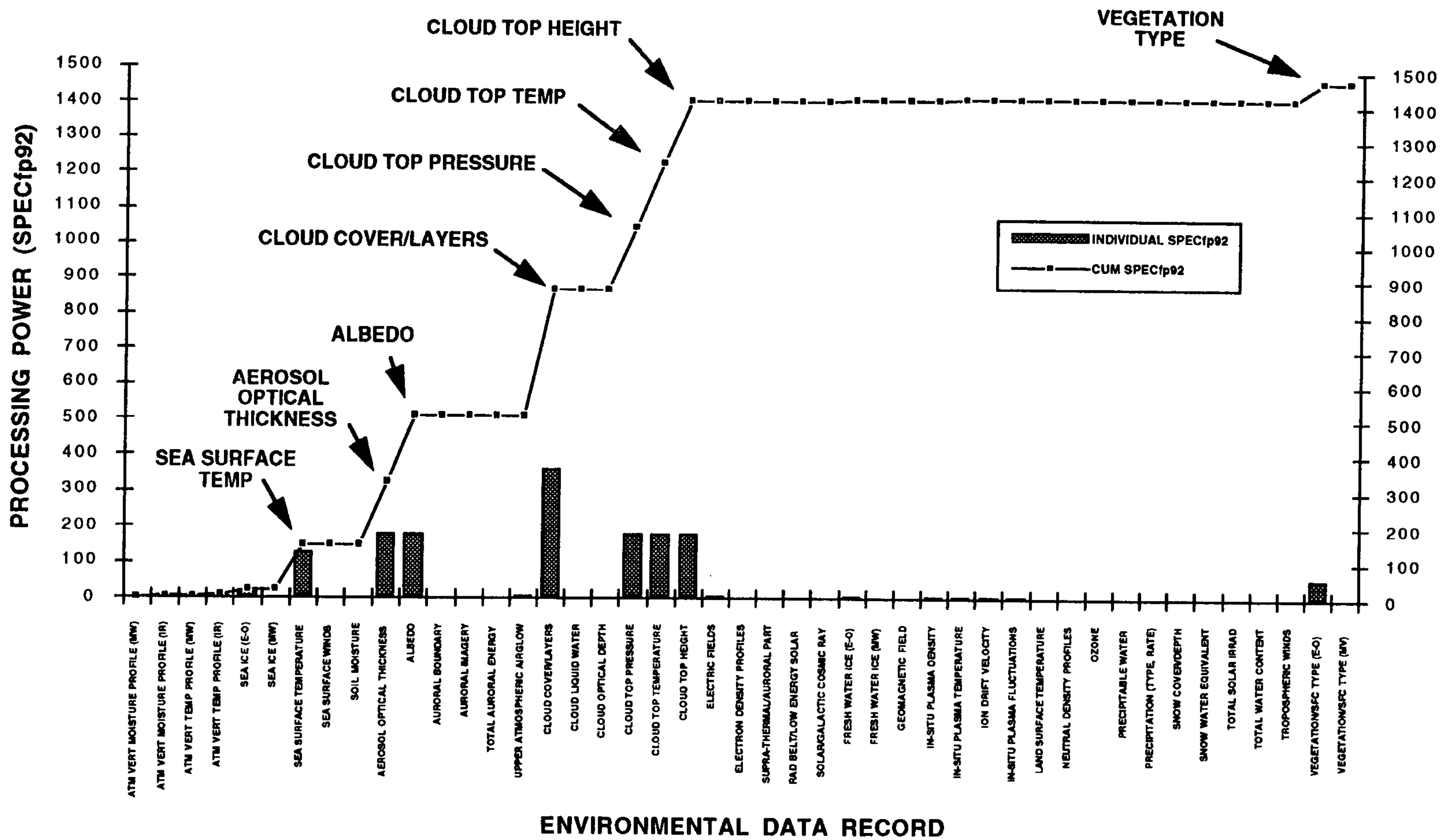
npoess



CONVERGENCE EFFORT MODIFICATION

CENTRAL ELEMENT BASELINE EDR PROCESSING

npoess

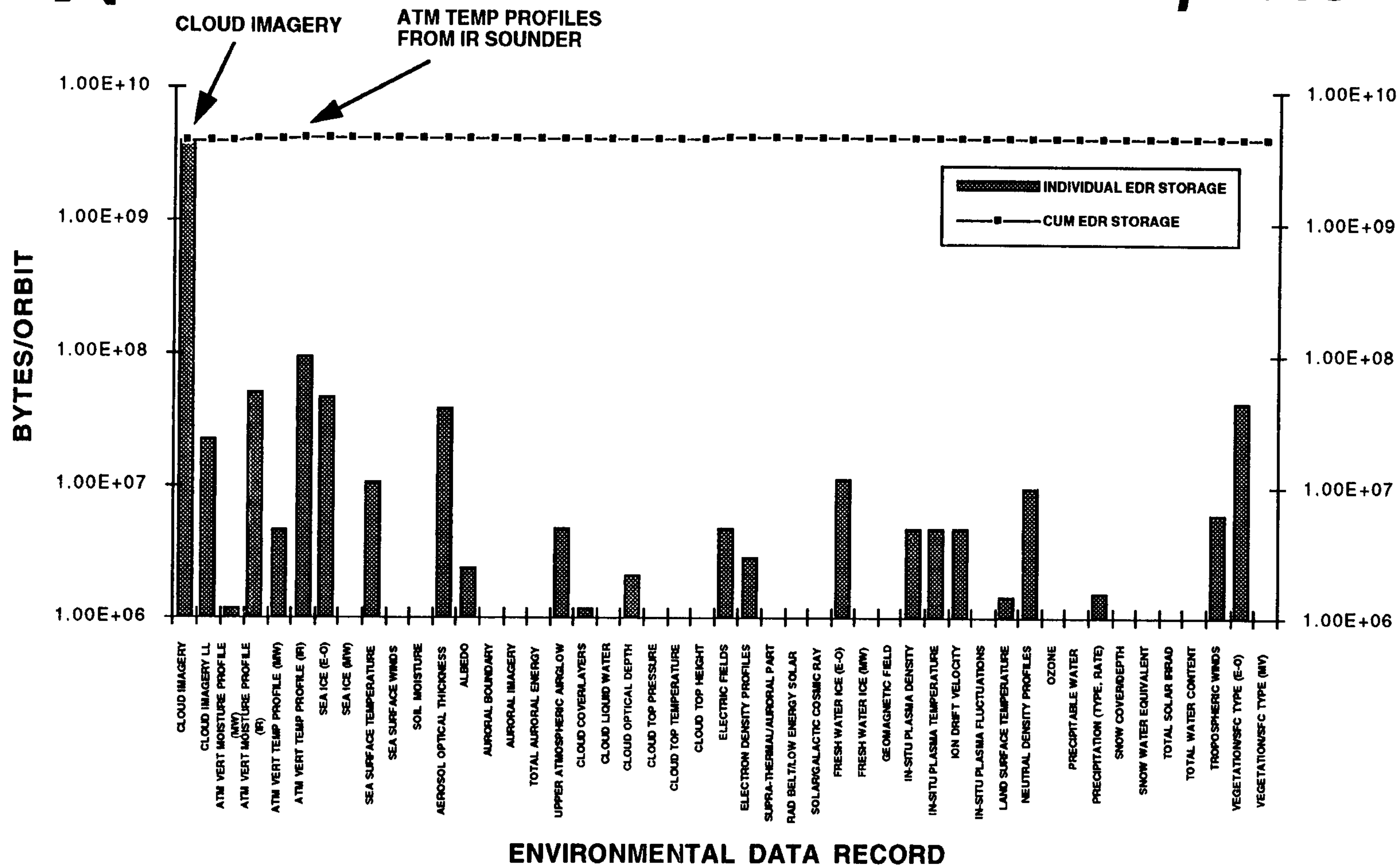


3/15/95

CONVERGENCE EFFORT MODIFICATION

CENTRAL ELEMENT BASELINE EDR STORAGE

npoess



NOTE: DOES NOT INCLUDE SDR STORAGE

3/15/95

npoess

IDPS FIELD TERMINAL

GREG LOGAN

3/15/95

FIELD TERMINAL EDR SELECTION CRITERIA

- EDRs THAT SUPPORT CURRENT AND PROJECTED OPERATIONS
- LIST INCLUDES, AT A MINIMUM, TODAY'S FIELD TERMINAL EDR REQUIREMENTS
- EDRS DERIVED FROM E-O, MICROWAVE IMAGER/ SOUNDER, AND IR SOUNDER SENSORS ONLY

CONVERGENCE EFFORT MODIFICATION

FIELD TERMINAL EDR REQUIREMENTS

npoess

ELECTRO-OPTICAL DERIVED EDRS

- CLOUD IMAGERY
- CLOUD COVER/LAYERS
- CLOUD TOP PRESSURE/HEIGHT/TEMPERATURE
- SEA SURFACE TEMPERATURE
- LAND SURFACE TEMPERATURE
- ALBEDO

μWAVE IMAGER/SOUNDER DERIVED EDRS

- ATMOSPHERIC VERTICAL MOISTURE PROFILE
- ATMOSPHERIC VERTICAL TEMPERATURE PROFILE
- TROPOSPHERIC WINDS
- SEA SURFACE WIND SPEED
- SEA ICE
- FRESH WATER ICE
- TOTAL WATER CONTENT
- CLOUD LIQUID WATER
- SOIL MOISTURE
- PRECIPITATION (TYPE, RATE)
- SNOW COVER/DEPTH
- VEGETATION/SURFACE TYPE

3/15/95

CONVERGENCE EFFORT MODIFICATION

FIELD TERMINAL EDR REQUIREMENTS HIGH RESOLUTION TERMINAL

npoess

EDR	RESOLUTION	UNCERTAINTY (ACCURACY)
CLOUD IMAGERY	0.65 KM	ACCURATE ENOUGH FOR FOLLOWING EDRS
CLOUD COVER/LAYERS	25 KM	85 % CLOUD DETECTION/TYPE
CLOUD TOP PRESSURE	25 KM	50 MB
CLOUD TOP HEIGHT	25 KM	0.5 KM
CLOUD TOP TEMP	25 KM	3.0° C
SEA SURFACE TEMP	4 KM	0.5° C
LAND SURFACE TEMP	4 KM	3.0° C
ALBEDO	10 KM	5 %
ATM VERT MOISTURE PROFILE	15 - 50 KM	APPROACH CENTRAL ELEMENT ACCURACY
ATM VERT TEMP PROFILE	15 - 50 KM	
TROPOSPHERIC WINDS	50 KM	
SEA SURFACE WIND SPEED	50 KM	
SEA ICE	50 KM	
FRESH WATER ICE	50 KM	
TOTAL WATER CONTENT	50 KM	
CLOUD LIQUID WATER	50 KM	
SOIL MOISTURE	50 KM	
PRECIPITATION	50 KM	
SNOW COVER/DEPTH	25 KM	
VEGETATION/SURFACE TYPE	50 KM	

3/15/95

CONVERGENCE EFFORT MODIFICATION

FIELD TERMINAL EDR REQUIREMENTS
LOW RESOLUTION TERMINAL

npoess

EDR	RESOLUTION	UNCERTAINTY (ACCURACY)
CLOUD IMAGERY	*2.6 KM*	ACCURATE ENOUGH FOR FOLLOWING EDRS
CLOUD COVER/LAYERS	25 KM	*80 % CLOUD DETECTION/TYPE*
CLOUD TOP PRESSURE	25 KM	50 MB
CLOUD TOP HEIGHT	25 KM	0.5 KM
CLOUD TOP TEMP	25 KM	3.0 °C
SEA SURFACE TEMP	4 KM	*1.0 °C*
LAND SURFACE TEMP	4 KM	*4.0 °C*
ALBEDO	10 KM	5 %
ATM VERT MOISTURE PROFILE	50 KM	APPROACH CENTRAL ELEMENT ACCURACY
ATM VERT TEMP PROFILE	50 KM	
TROPOSPHERIC WINDS	50 KM	
SEA SURFACE WIND SPEED	50 KM	
SEA ICE	50 KM	
FRESH WATER ICE	50 KM	
TOTAL WATER CONTENT	50 KM	
CLOUD LIQUID WATER	50 KM	
SOIL MOISTURE	50 KM	
PRECIPITATION	50 KM	
SNOW COVER/DEPTH	25 KM	
VEGETATION/SURFACE TYPE	50 KM	

NOTE: ITALICIZED VALUES REPRESENT RELAXED REQUIREMENTS FROM THE HIGH DATA RATE TERMINAL

3/15/95

CONVERGENCE EFFORT MODIFICATION

FIELD TERMINAL DOWNLINK SELECTION RATIONALE

- GENERAL SELECTION CRITERIA
  - DATA RATE WITHIN EXISTING CAPABILITY OF FIELD TERMINALS
  - ALL CHANNELS OF E-O SENSOR
  - TRANSMIT ALL SENSOR DATA NECESSARY TO MEET DOD & DOC FIELD TERMINAL EDR REQUIREMENTS
    - » E-O AND MICROWAVE IMAGER/SOUNDERS
- ADDITIONAL SELECTION CRITERIA FOR HIGH RESOLUTION TERMINAL
  - FULL-RESOLUTION E-O SENSOR (0.65 KM)
  - TRANSMIT ALL SENSORS NECESSARY TO MEET DOC AND CIVILIAN RDR & EDR REQUIREMENTS
    - » ADD IR SOUNDER
- ADDITIONAL SELECTION CRITERIA FOR LOW RESOLUTION TERMINAL
  - E-O IMAGERY AT A RESOLUTION COMPARABLE TO DMSP 5D-3 REALTIME DATA SMOOTH BUT BETTER THAN POES APT
  - MINIMIZE COMPRESSION

CONVERGENCE EFFORT MODIFICATION

HIGH RESOLUTION DOWNLINK ALTERNATIVES

npoess

	SENSOR OUTPUT	*RECEIVED RESOLUTION &COMPRESSION*				
OASIS RESOLUTION OASIS COMPRESSION AIRS COMPRESSION	0.65 KM	0.65 KM 4:1	0.65 KM 8:1 4:1	1.3 KM 2:1	1.3 KM 4:1 4:1	1.3 KM 2:1 2:1
			DATA RATES			
OASIS (ALL Channels)	4500	1125	563	563	281	563
μWAVE IMAGER	9.9	9.9	9.9	9.9	9.9	9.9
μWAVE SOUNDERS	7.4	7.4	7.4	7.4	7.4	7.4
AIRS	1420	0	355	0	355	810
TOTAL SENSOR DATA RATE	5937	1142	935	580	653	1390
15% OVERHEAD	891	171	140	87	98	209
DATA RATE (KbPS)	6828	1313	1075	667	751	1599

DMSP 5D-3 EQUIVALENT (0.65 KM, 4:1) — BASELINE SELECTION (0.65 KM, 8:1, 4:1) — POES K-N EQUIVALENT (1.3 KM, 4:1, 4:1)

3/15/95

CONVERGENCE EFFORT MODIFICATION

LOW RESOLUTION DOWNLINK ALTERNATIVES

npoess

OASIS RESOLUTION / OASIS COMPRESSION	RECEIVED RESOLUTION &COMPRESSION					
	0.65 KM AND 16:1	1.3 KM AND 16:1	2.6 KM AND 4:1	2.6 KM AND 8:1	2.6 KM AND 4:1	3.9 KM AND 1:1
DATA RATES						
OASIS (# of Channels)	80.4 (2)	70.3 (8)	70.3 (8)	35.2 (8)	40.1 (4)	35.8 (2)
μWAVE IMAGER	9.9	9.9	9.9	9.9	9.9	0
μWAVE SOUNDERS	7.4	7.4	7.4	7.4	7.4	0
AIRS	0	0	0	0	0	0
TOTAL SENSOR DATA RATE	97.7	87.6	87.6	52.5	57.4	35.8
15% OVERHEAD	14.7	13.1	13.1	7.9	8.6	5.4
DATA RATE (KBPS)	112.4	100.7	100.7	60.4	66.0	41.2
			BASELINE SELECTION	DMSP 5D-3 EQUIVALENT		POES APT EQUIVALENT

3/15/95

CONVERGENCE EFFORT MODIFICATION

IDPS FIELD TERMINAL BASELINE

npoess

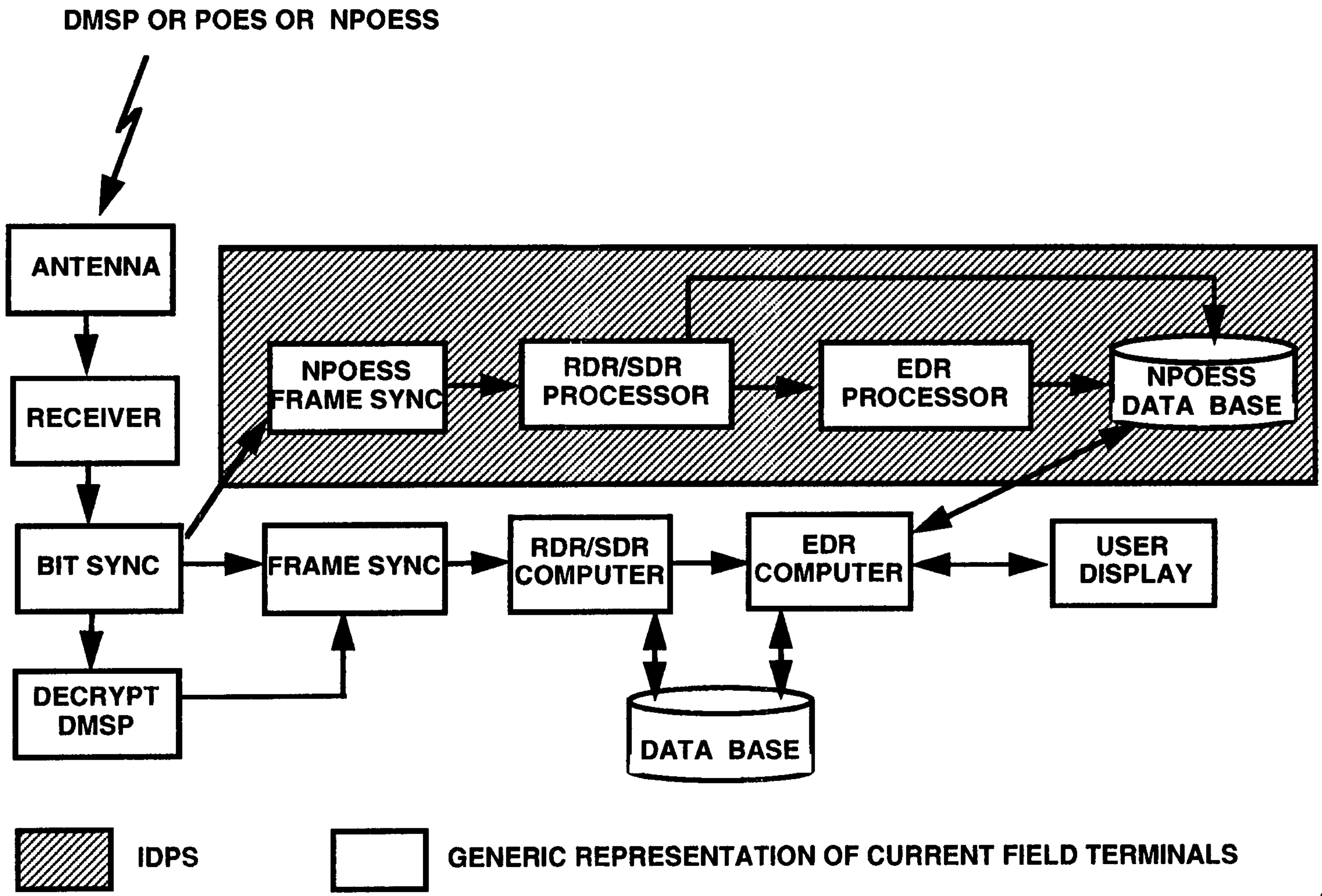
- ALTERNATIVES/ASSUMPTIONS:
  - NPOESS TRANSMITS:
    - » "L" OR "S" BAND FOR HIGH DATA RATE ~ 1MBPS
      - ELECTRO-OPTICAL, μWAVE IMAGER/SOUNDERS, AND IR SOUNDER SENSOR DATA ONLY
      - ALL CHANNELS OF E-O (COMPRESSED), 0.65 KM RESOLUTION IMAGERY
    - » "S" BAND AND/OR UHF FOR LOW DATA RATE ~ 100 KBPS
      - ELECTRO-OPTICAL AND μWAVE IMAGER/SOUNDER SENSOR DATA ONLY
      - ALL CHANNELS OF E-O (COMPRESSED) , 2.6 KM RESOLUTION IMAGERY
  - FIELD TERMINALS PROCESS AND STORE EDRS WITHIN THEIR STATED REQUIREMENTS
- IMPACTS:
  - NO MODIFICATION TO: ANTENNA, RECEIVER, AND BIT SYNC
  - MODIFICATION, REPLACEMENT, OR ADDITION OF:
    - » FRAME SYNCHRONIZER - ADD NPOESS FORMAT
    - » COMPUTER PROCESSORS - CPU, RAM, DECOMPRESSION CARD
    - » MASS STORAGE
    - » SOFTWARE

3/15/95

CONVERGENCE EFFORT MODIFICATION

IDPS FIELD TERMINAL PROCESSING

npoess



3/15/95

CONVERGENCE EFFORT MODIFICATION

CURRENT IDPS FIELD TERMINAL PROCESSING CAPABILITIES

npoess

- **PROCESSING POWER IS DEPENDENT ON EACH FIELD TERMINAL'S EDR REQUIREMENTS**
  - BASIC STT:
    - » VIS/IR IMAGERY AVAILABLE WITHIN 2 MINUTES OF END OF PASS
    - » NO EDR GENERATION CAPABILITY - GOAL
  - ENHANCED STT:
    - » VIS/IR IMAGERY AVAILABLE WITHIN 2 MINUTES OF END OF PASS
    - » UPON USER REQUEST, GENERATE ANY EDR WITHIN 1 MINUTE
  - MARK IVB:
    - » VIS/IR IMAGERY WITHIN 5 MINUTES OF END OF PASS
    - » ALL EDRS PROCESSED WITHIN 20 MINUTES OF END OF PASS
  - TESS(3): VIS/IR IMAGERY AVAILABLE WITHIN 5 MIN OF END OF PASS
    - » SSM/I EDR GENERATION DONE WITHIN THE AVAILABLE PROCESSING POWER OF THE SYSTEM
  - AN/SMQ-11: VIS/IR IMAGERY ONLY - AVAILABLE AT END OF PASS
  - MARK IV: VIS/IR IMAGERY ONLY - AVAILABLE AT END OF PASS

3/15/95

CONVERGENCE EFFORT MODIFICATION

IDPS FIELD TERMINAL BASELINE PROCESSING TIMELINE REQUIREMENTS

npoess

- RECOMMENDED REQUIREMENT
  - VIS/IR IMAGERY AVAILABLE WITHIN 1 MINUTE OF END OF PASS
  - ALL MICROWAVE SDRs AVAILABLE WITHIN 2 MINUTES OF END OF PASS
  - ALL EDRs AVAILABLE WITHIN 10 MINUTES OF END OF PASS
- RATIONALE
  - REFLECTS PERCEIVED OPERATIONAL NEEDS WITH REASONABLE RANGE OF PROCESSING POWER

CONVERGENCE EFFORT MODIFICATION

CURRENT IDPS FIELD TERMINAL CLOUD IMAGERY EDR STORAGE CAPABILITIES

npoess

- EDR STORAGE IS DEPENDENT ON EACH FIELD TERMINAL'S E-O IMAGERY STORAGE REQUIREMENTS
  - BASIC STT:
    - » 5 PASSES OF LOW RESOLUTION VIS/IR IMAGERY
  - ENHANCED STT:
    - » THE LATEST PASS OF HIGH RESOLUTION VIS/IR IMAGERY
    - » 4 PASSES OF LOW RESOLUTION (5:1 SMOOTHED) VIS/IR IMAGERY
  - MARK IVB:
    - » THE LATEST PASS OF HIGH RESOLUTION VIS/IR IMAGERY
    - » 14 PASSES OF LOW RESOLUTION (5:1 SMOOTHED) VIS/IR IMAGERY
  - TESS(3): THREE PASSES OF HIGH RESOLUTION VIS/IR IMAGERY
  - AN/SMQ-11: NO INTERNAL MASS STORAGE; 8 PASSES ON TAPE
  - MARK IV: ONE PASS OF HIGH RESOLUTION VIS/IR IMAGERY; PREVIOUS PASSES ON TAPE

3/15/95

IDPS FIELD TERMINAL BASELINE EDR STORAGE REQUIREMENTS

- RECOMMENDED REQUIREMENT
  - BASIC STT, ENHANCED STT, MARK IVB, TESS 3, DOC TERMINALS SAME AS CURRENT SYSTEMS
  - AN/SMQ-11 AND MARK IV
    - LATEST PASS OF HIGH RESOLUTION VIS/IR IMAGERY
    - 4 LATEST PASSES OF LOW RESOLUTION VIS/IR IMAGERY
- RATIONALE
  - REFLECTS PERCEIVED OPERATIONAL NEEDS

CONVERGENCE EFFORT MODIFICATION

FIELD TERMINAL E-O IMAGERY EDR STORAGE

npoess

	CURRENT CAPABILITY			PROPOSED CAPABILITY		
	SIZE OF OF EACH PASS	NO. OF PASSES STORED	TOTAL	SIZE OF NPOESS PASS	NO. OF PASSES STORED	TOTAL
BASIC STT	5.2 MB	5	26 MB	36 MB	5	180 MB
ENHANCED STT	60 MB 2.4 MB	1 4	60 MB 9.6 MB	582 MB 36 MB	1 4	582 MB 144 MB
MARK IVB	315 MB 12 MB	1 14	315 MB 168 MB	582 MB 36 MB	1 14	582 MB 504 MB
TESS(3)	86 MB	3	258 MB	582 MB	3	1746 MB
AN/SMQ-11	60 MB	8 TAPE	480MB TAPE	582 MB 36 MB	1 4	582 MB 144 MB
MARK IV	60 MB	1	60 MB	582 MB 36 MB	1 4	582 MB 144 MB
DOC TERMINAL	60 MB	TBS	TBS	582 MB 36 MB	1 4	582 MB 144 MB

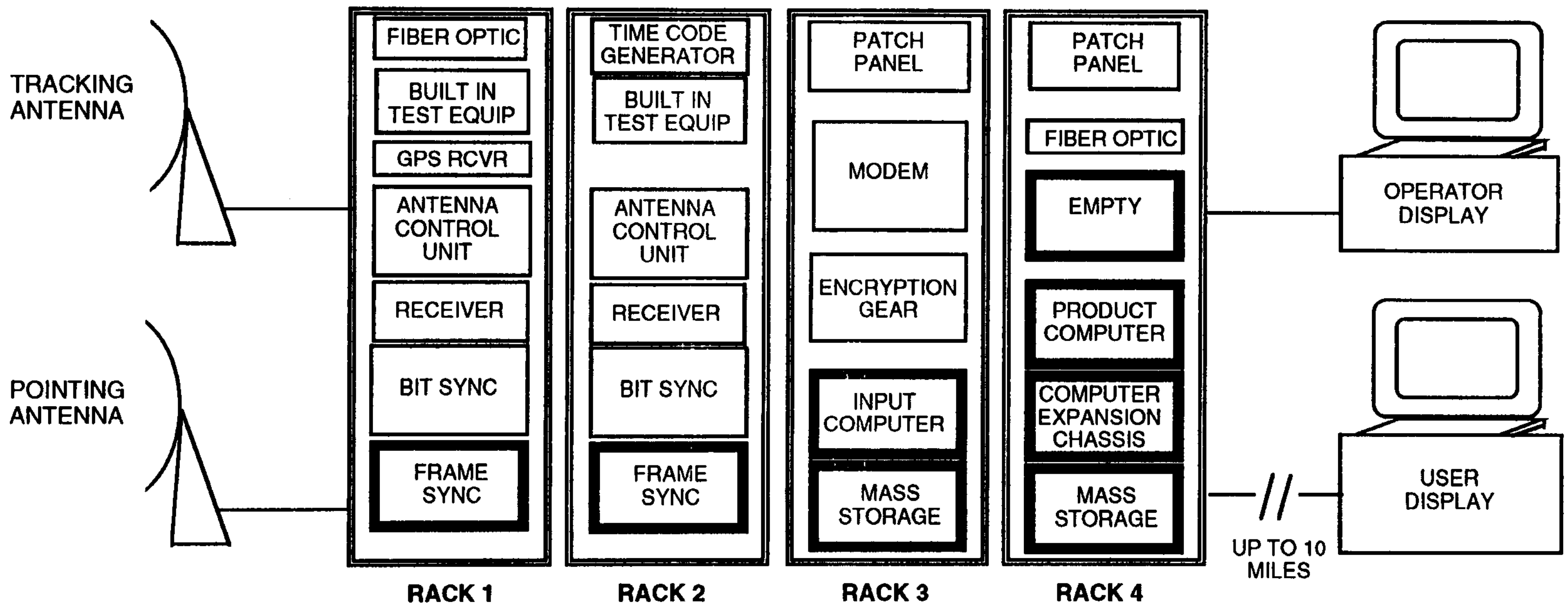
MB: MEGABYTES

3/15/95

CONVERGENCE EFFORT MODIFICATION

CURRENT MARK IVB ARCHITECTURE

npoess



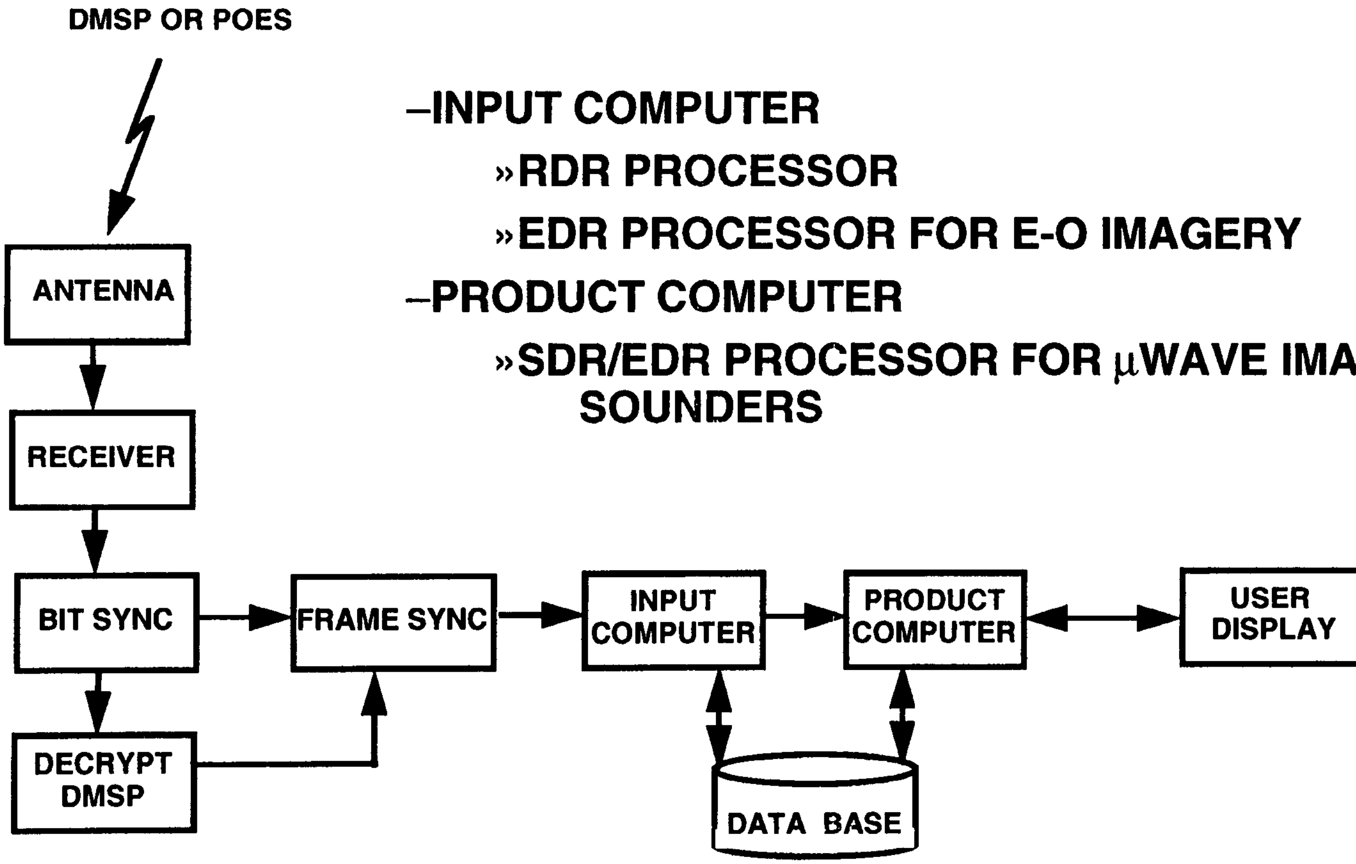
MARK IVB RECEIVES DMSP OR POES; GOES OR GMS OR METEOSAT

AREAS UNDER CONSIDERATION FOR MODIFICATION

3/15/95

CURRENT MARK IVB DATA FLOW

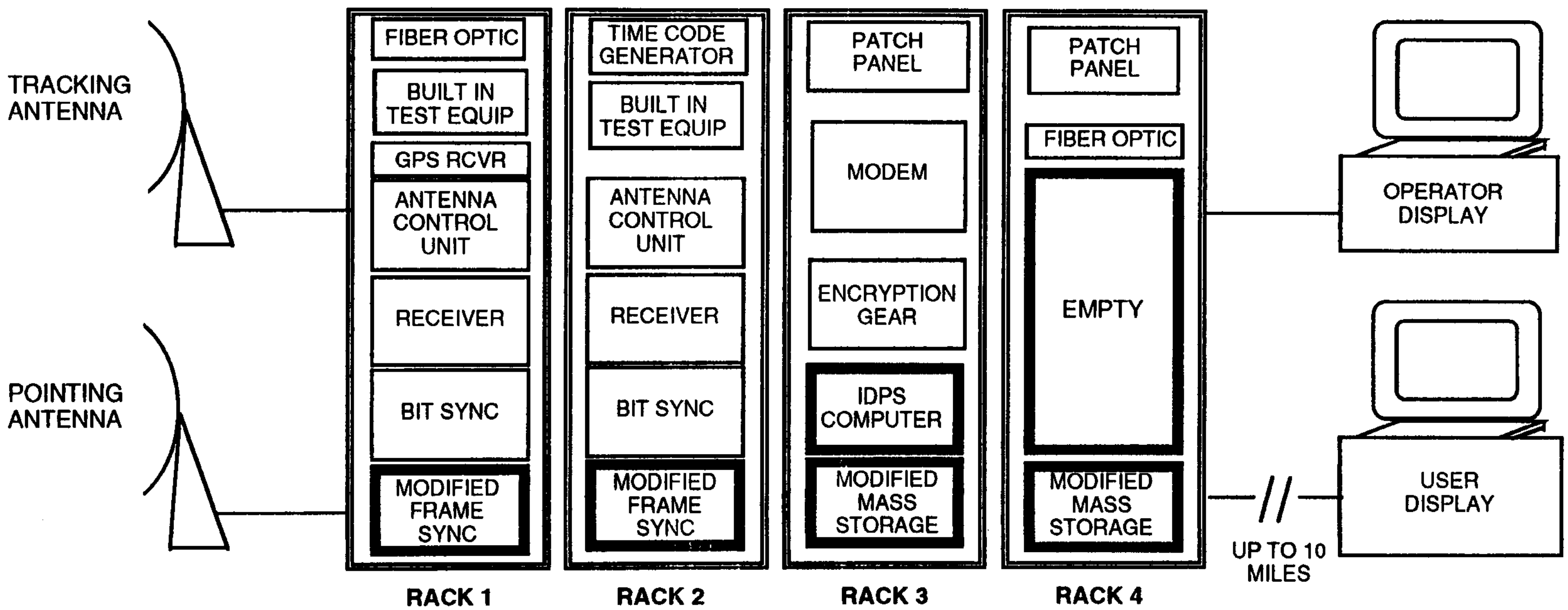
- INPUT COMPUTER
  - » RDR PROCESSOR
  - » EDR PROCESSOR FOR E-O IMAGERY
- PRODUCT COMPUTER
  - » SDR/EDR PROCESSOR FOR μWAVE IMAGER AND SOUNDERS



3/15/95

MODIFIED MARK IVB FOR NPOESS DESIGN ALTERNATIVE 1

npoess



MARK IVB RECEIVES DMSP OR POES OR *NPOESS*; GOES OR GMS OR METEOSAT

MODIFIED COMPONENTS FOR THIS ALTERNATIVE

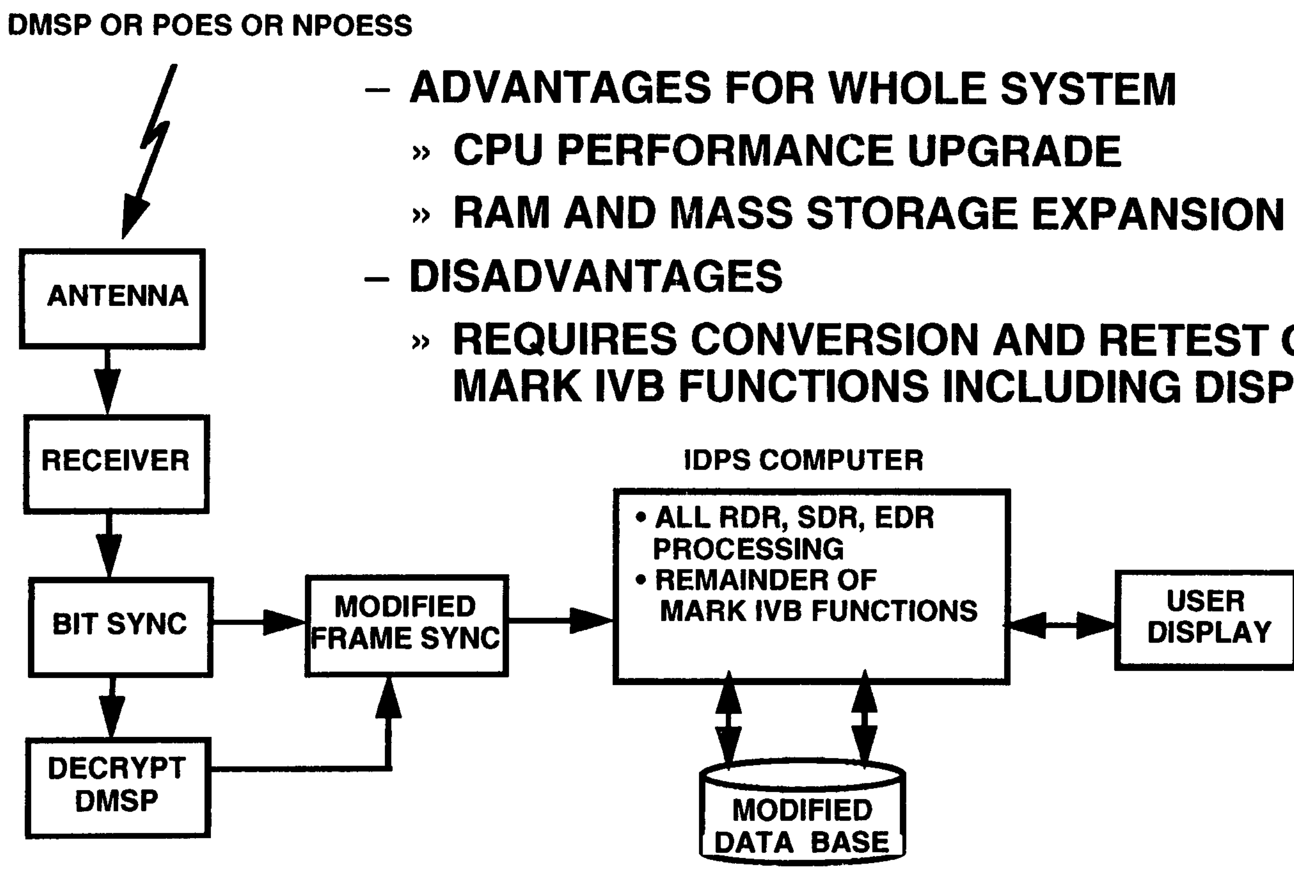
3/15/95

CONVERGENCE EFFORT MODIFICATION

MODIFIED MARK IVB FOR NPOESS DESIGN ALTERNATIVE 1

npoess

- ADVANTAGES FOR WHOLE SYSTEM
  - » CPU PERFORMANCE UPGRADE
  - » RAM AND MASS STORAGE EXPANSION
- DISADVANTAGES
  - » REQUIRES CONVERSION AND RETEST OF ALL MARK IVB FUNCTIONS INCLUDING DISPLAYS

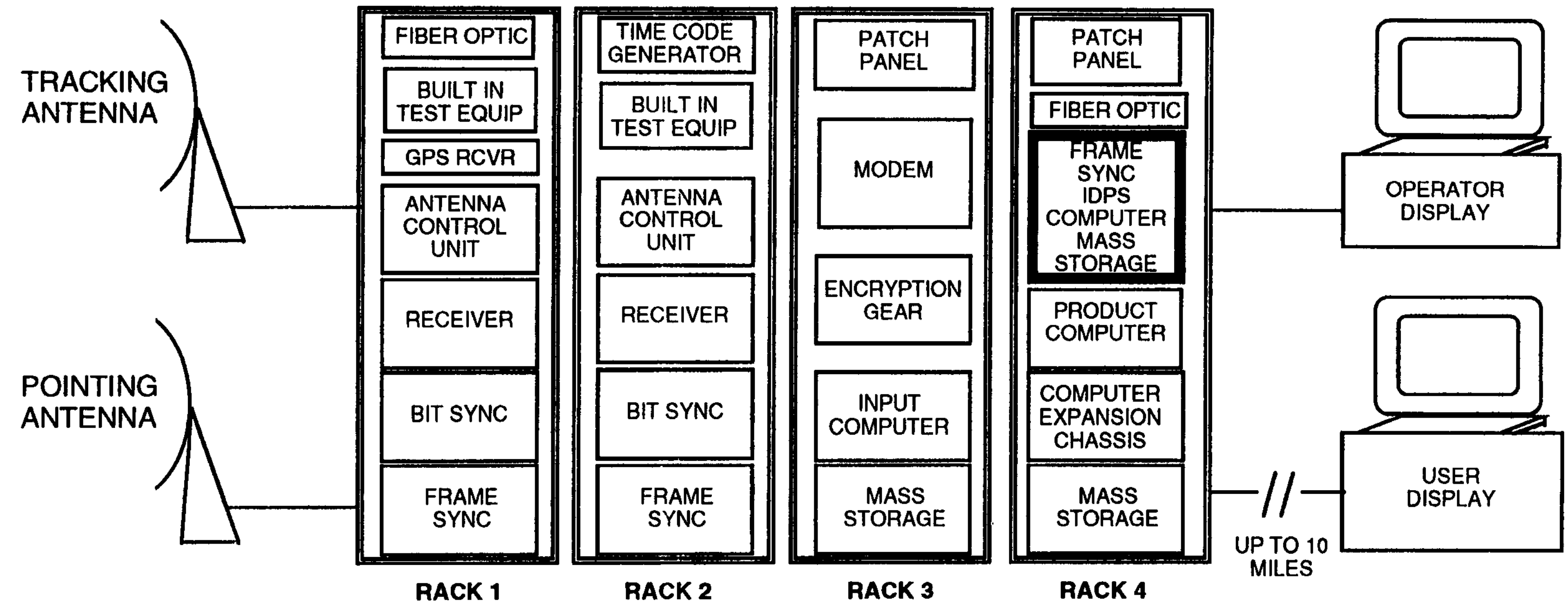


3/15/95

CONVERGENCE EFFORT MODIFICATION

MODIFIED MARK IVB FOR NPOESS DESIGN ALTERNATIVE 2

npoess



MARK IVB RECEIVES DMSP OR POES OR *NPOESS*; GOES OR GMS OR METEOSAT

MODIFIED COMPONENTS FOR THIS ALTERNATIVE

3/15/95

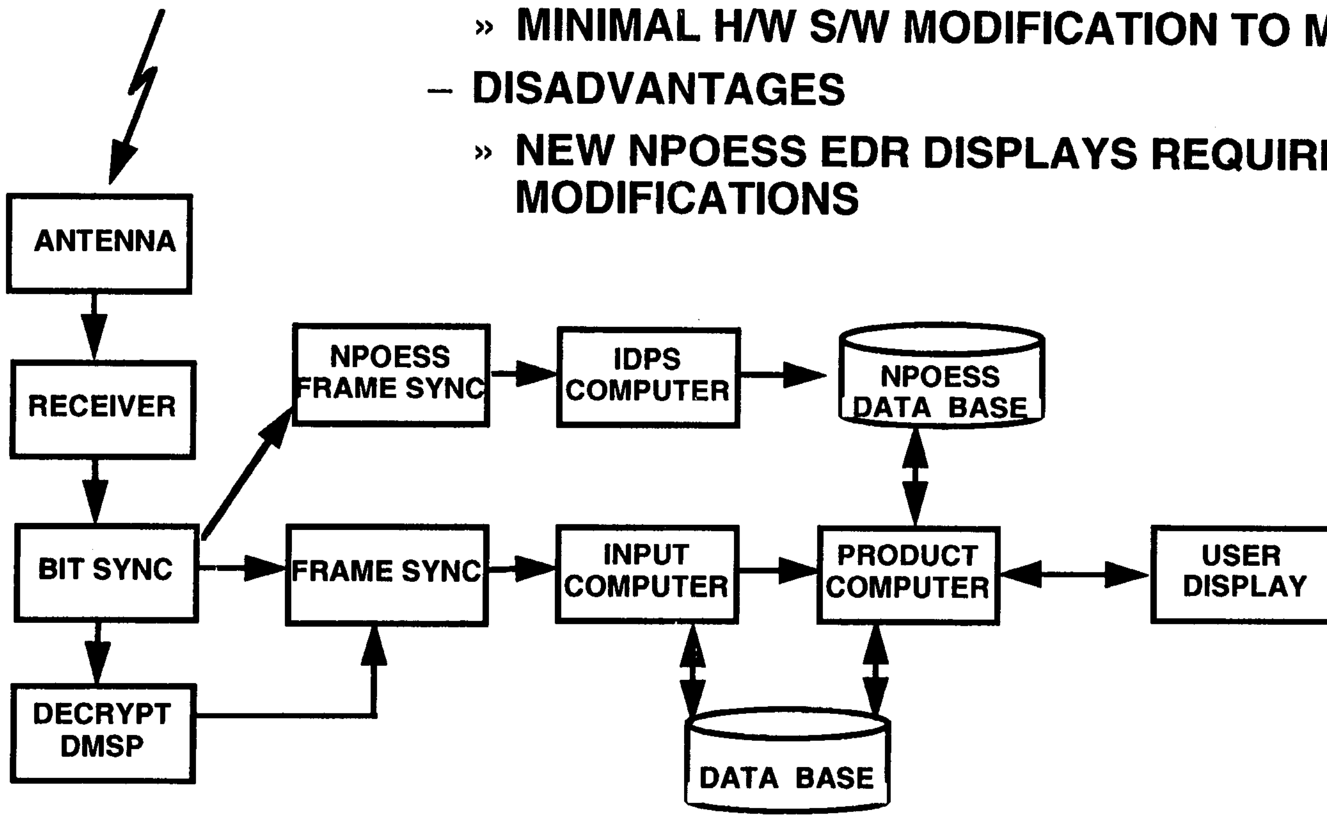
CONVERGENCE EFFORT MODIFICATION

MODIFIED MARK IVB FOR NPOESS DESIGN ALTERNATIVE 2

npoess

DMSP OR POES OR NPOESS

- ADVANTAGES
  - » MINIMAL H/W S/W MODIFICATION TO MARK IVB
- DISADVANTAGES
  - » NEW NPOESS EDR DISPLAYS REQUIRE MARK IVB MODIFICATIONS



3/15/95

SUMMARY

npoess

- DISCUSSED INTERPRETATION OF REQUIREMENTS ISSUES
- DEVELOPED BASELINE CENTRAL ELEMENT PROCESSING/STORAGE SIZING
- PROPOSED EDRS TO BE PROCESSED IN FIELD TERMINALS
- PROVIDED ALTERNATIVES FOR FIELD TERMINAL DOWNLINKS
- DEVELOPED BASELINE FIELD ELEMENT PROCESSING/STORAGE
- DEVELOPED ALTERNATIVES FOR NPOESS MODIFICATION TO MARK IVB

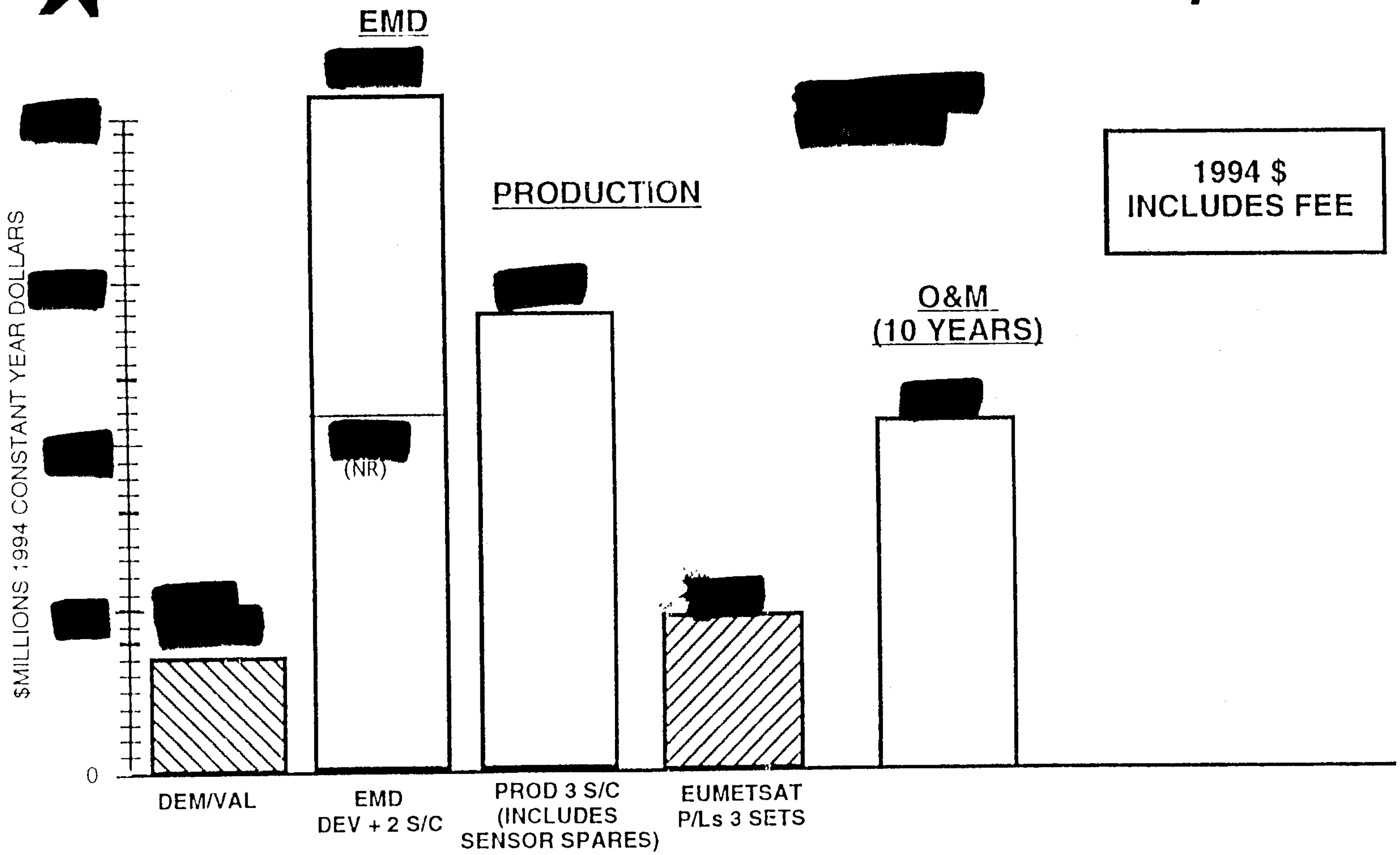
LCC COST SUMMARY

M. WHITTEN

CONVERGENCE EFFORT MODIFICATION

PRELIMINARY COST ESTIMATE FOR THE BASELINE SYSTEM

npoess



TOTAL: [redacted]

3/15/95

CONVERGENCE EFFORT MODIFICATION

SPACE SEGMENT LCC ASSUMPTIONS

npoess

- U.S. PROVIDED SATELLITES O1 AND O3
  - TWO OF EACH WITH A COMMON SPARE
- SENSORS FOR EUMETSAT S/C (O2)
  - THREE SETS
- INCORPORATED SPACECRAFT CHANGES
  - INCREASED MEMORY AND DATA THROUGHPUT
  - X-BAND SMD D/L & MULTIPLE REAL-TIME LINKS
- FACTORY TO PAD LAUNCH OPERATIONS

3/15/95

GROUND SEGMENTS LCC ASSUMPTIONS

- USER SEGMENT INCLUDES
  - FRONT END PROCESSORS & DBMS AT AFGWC, FNMOC, AFSFC, AND NESDIS
  - PROTOTYPE DEVELOPMENT UNITS FOR HRPT & LRPT TERMINALS ARE NOT INCLUDED
  - ALGORITHMS FOR MICROWAVE SOUNDERS, AND AIRS NOT INCLUDED
- C^3 SEGMENT INCLUDES
  - ADDS USER SITE COMM TERMINALS AT NESDIS, AFGWC, AND EUMETSAT
  - PROVIDES C^3 SITE COMM TERMINALS AT SUITLAND, FALCON, AND FOUR RTS/CDA SITES
  - 44 MBPS DATA THROUGHPUT CAPABILITY FOR DRR
  - OPERATIONAL SOC AT SUITLAND, B/U AT FBSOC
  - ASSUMES X-BAND TERMINALS ALREADY EXIST AT RTS/CDA SITES

SURVIVABILITY

- REQUIREMENT
  - THE SATELLITE SHALL BE DESIGNED SUCH THAT NO MISSION DEGRADATION OCCURS AFTER EXPOSURE TO THE COMBINED NATURAL AND HOSTILE ENVIRONMENTS
  - HOSTILE ENVIRONMENT IS IN APPENDIX B (TBR)
    - PREVIOUS SURVIVABILITY REQUIREMENTS LIMITED TO OMIS, MISS, AND SPACECRAFT
- ISSUES
  - THREAT ENVIRONMENT DEFINITION
  - SCOPE OF MISSION (I,E., PRIMARY MISSION - OASIS, MISS, & AIRS)
  - NOT DEGRADE VERSUS MAINTAIN FULL MISSION CAPABILITY
- IMPLEMENTATION PHILOSPHY
  - IMPROVE SYSTEM SURVIVABILITY WITH LOW RISK, LOW COST ENHANCEMENTS
  - IDENTIFY DELTA COSTS

LIFE CYCLE DOCUMENT PLAN/STATUS
(CDRL A014)

- PART 1 - LCC MODEL DESCRIPTION
  - WBS UPDATE IN PROGRESS
  - USE OF LOCKHEED STAR MODEL, AND DATA BASE, HARDWARE ACTUAL, DIRECT ESTIMATES (IN HOUSE AND SUPPLIER)
  - USE OF SEER FOR SOFTWARE, BOTTOM UP CODING ESTIMATES
- PART II - LCC ESTIMATE/SYSTEM DESCRIPTION
  - PROGRAM HARDWARE/SOFTWARE LISTS: PHSL UPDATES IN PROGRESS, PHSL PER WBS OUTLINE
  - DESCRIBES BASE LINE SYSTEM
  - ALTERNATIVES AND OPTIONAL SYSTEMS ARE CORRELATED
  - COST RISK ANALYSIS
- PART III - METHODOLOGY / TRADE STUDY / ANALYSES
  - TRADE STUDIES AND ANALYSIS IMPACT ON LCC

REVIEW DRAFT LCC DOCUMENT WITH SPO BY MAY 26; DELIVER ON JUNE 16, 1995.

SUMMARY AND ACTION ITEM UPDATE

J. VASQUEZ