0845 start

DMSP BLOCK SIX RISK REDUCTION

DMSP/POES PAYLOAD ACCOMMODATION STUDY TIM #2

19 OCTOBER 1993

CONTRACT F04701-91-C-0068

Prepared for:

USAF/AFMC/CIB
SPACE & MISSILE SYSTEMS CENTER
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I.7

INTRODUCTION--OVERVIEW

- O TECHNICAL INTERCHANGE MEETING (TIM) #1
  - -- 2 SEPT 93
  - -- PAYLOAD IMPACTS/ACCOMMODATION
  - -- PRELIMINARY DMSP B/L VS CONFIG "C3"
- O SENSOR DATA BASES ESTABLISHED, CONFIGURATIONS DEVELOPED AND ACCOMMODATED
- O DRIVERS SUMMARIZED:

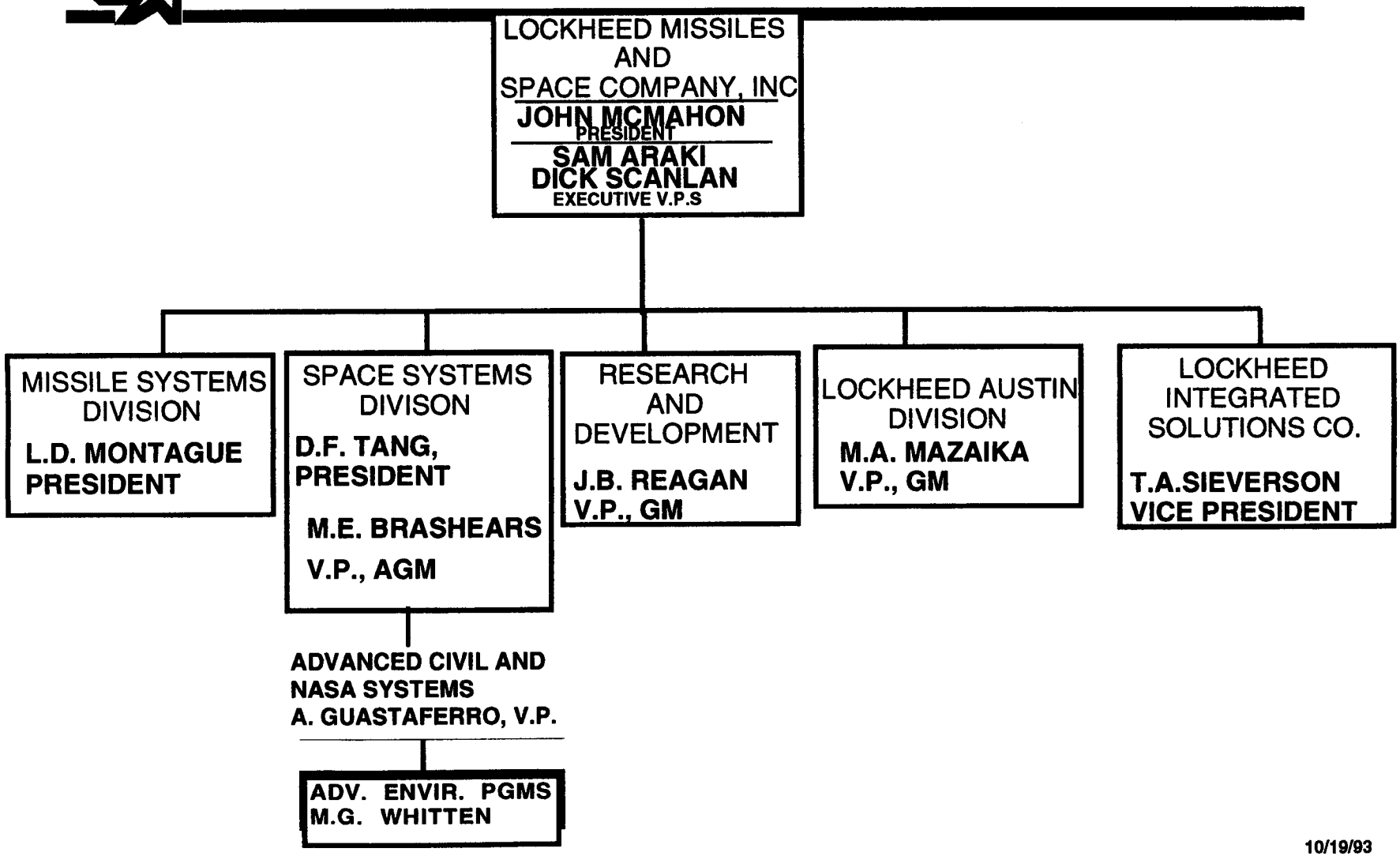
  OMIS DATA RATE DOUBLES WITH 12 BITS, 8 CHANNELS AND NO COMPRESSION

  AIRS DATA RATE ALSO DRIVES THE DATA HANDLING

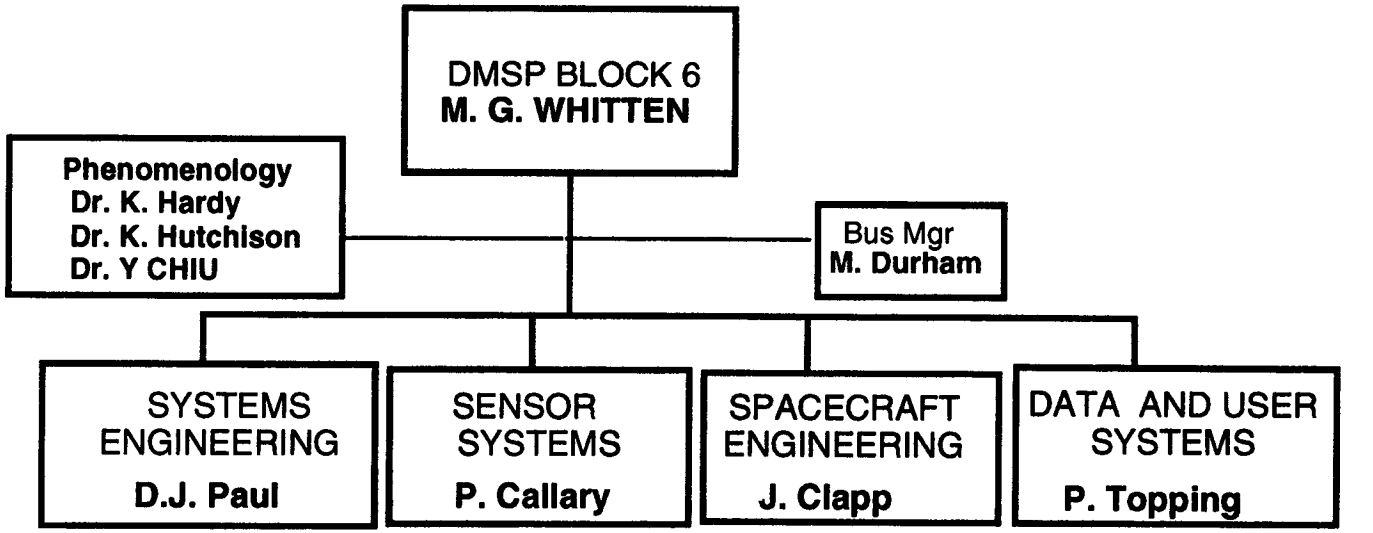
  ALTITUDE SELECTION AN ISSUE

  GROWTH: SPACE AND FOV THE ISSUE, WEIGHT AND POWER NOT A RISK

ORGANIZATION



PROGRAM ORGANIZATION



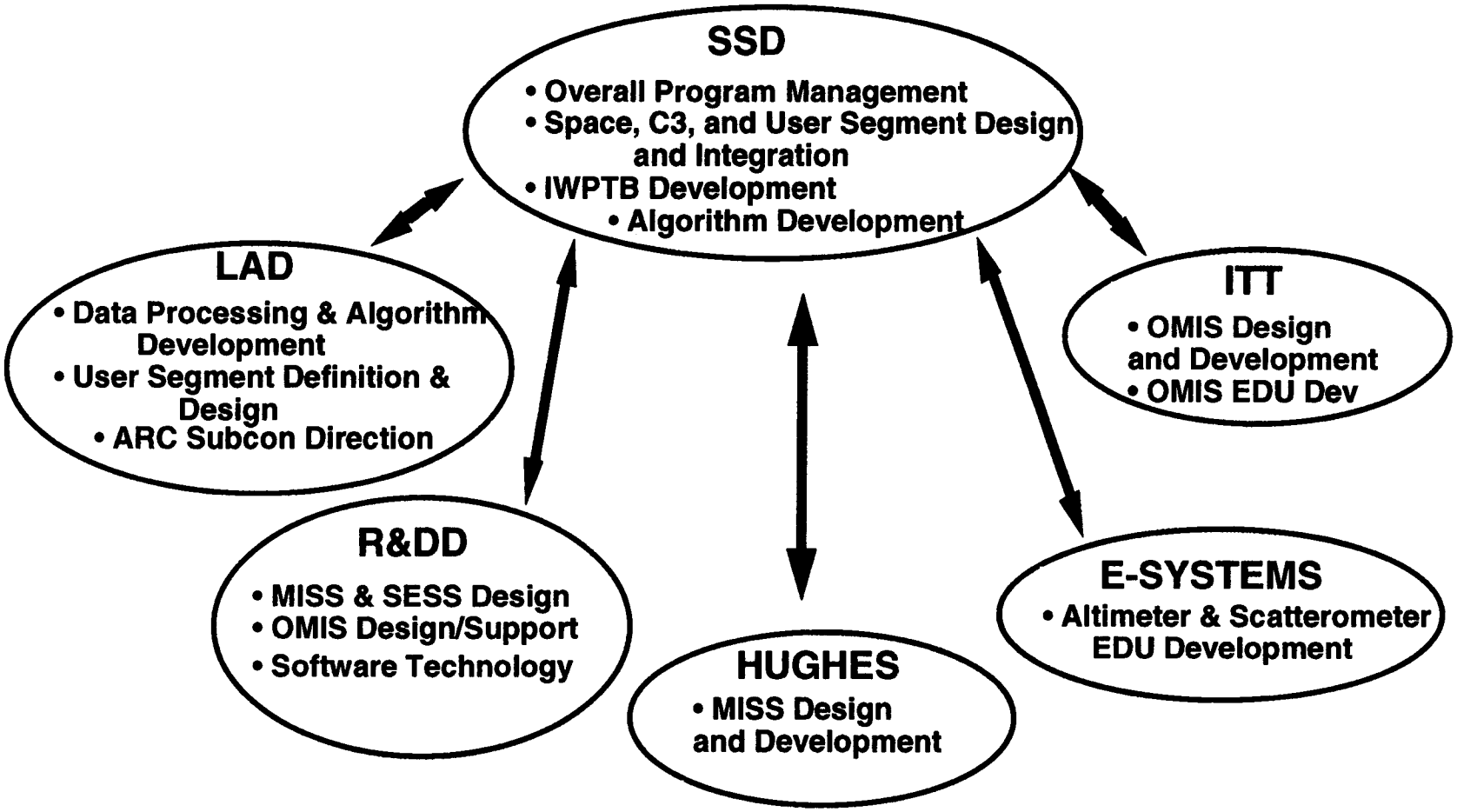
SYSTEMS ENGR
C3 INTEGRATION
RISK ANALYSIS
OPS CONCEPTS
MISSION ANALYSIS
REQMTS ANALYSIS
TECHNOLOGY DVLPMT
SPECIALTY ENG'R
LOGISTICS
NAVY REQMTS/STUDIES

OMIS DEVELOPMENT
EDU DEVELOPMENT
ITT INTERFACE
PAYLOAD TRADES
SENSOR DESIGN
R&DD SUPPORT
MISS DEVELOPMENT
SESS DEVELOPMENT

SPACECRAFT ENGR
BUS INTEGRATION
SENSOR INTEGRN
F-SAT ADAPTATION

USER SEGMENT
IWPTB DEVELOPMENT
LAD SUPPORT
OBP DEVELOPMENT
ALGORITHM DEVELOPMENT
CREST

TEAM RESPONSIBILITIES

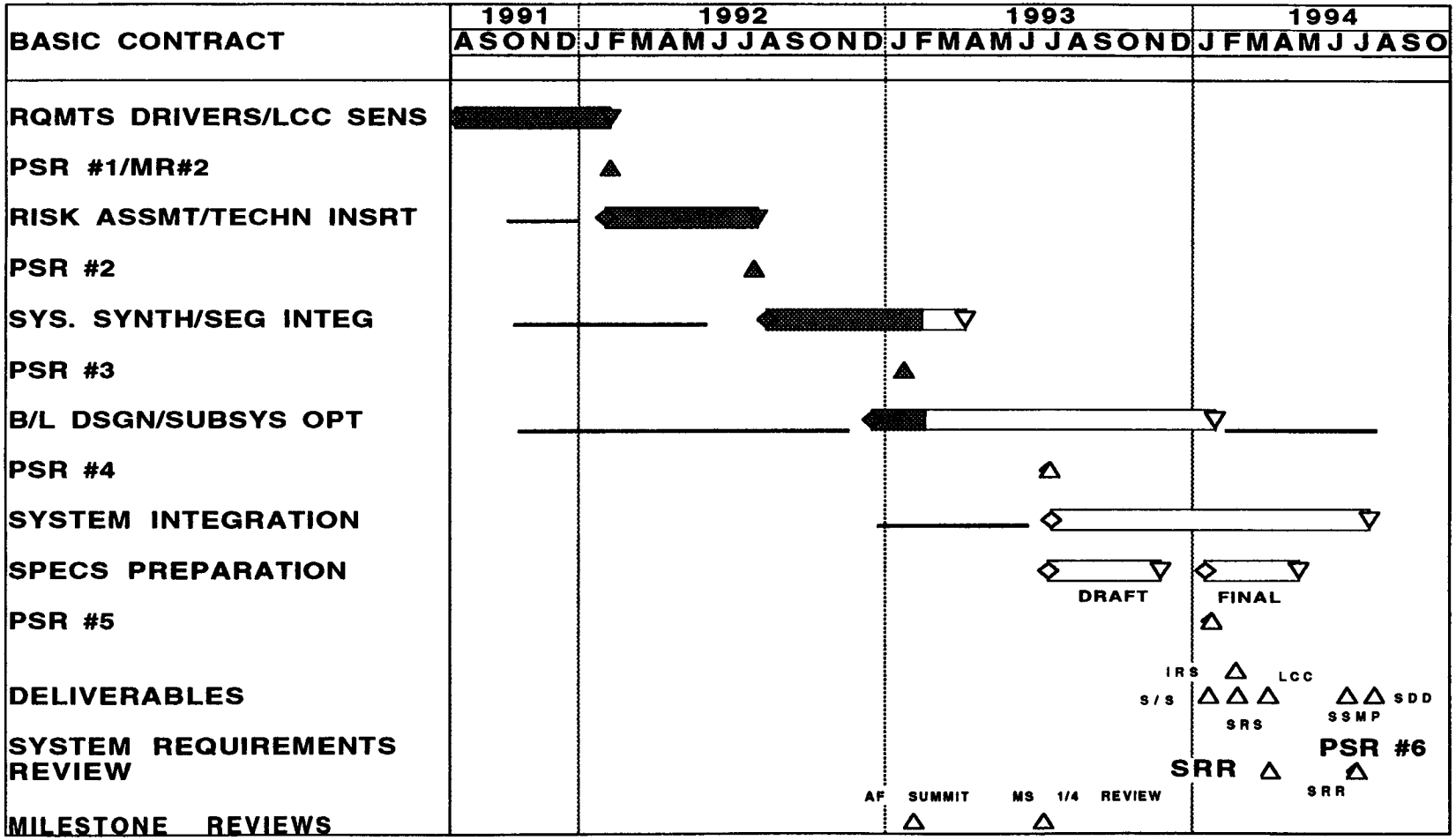


LMSC MANAGEMENT PHILOSOPHY

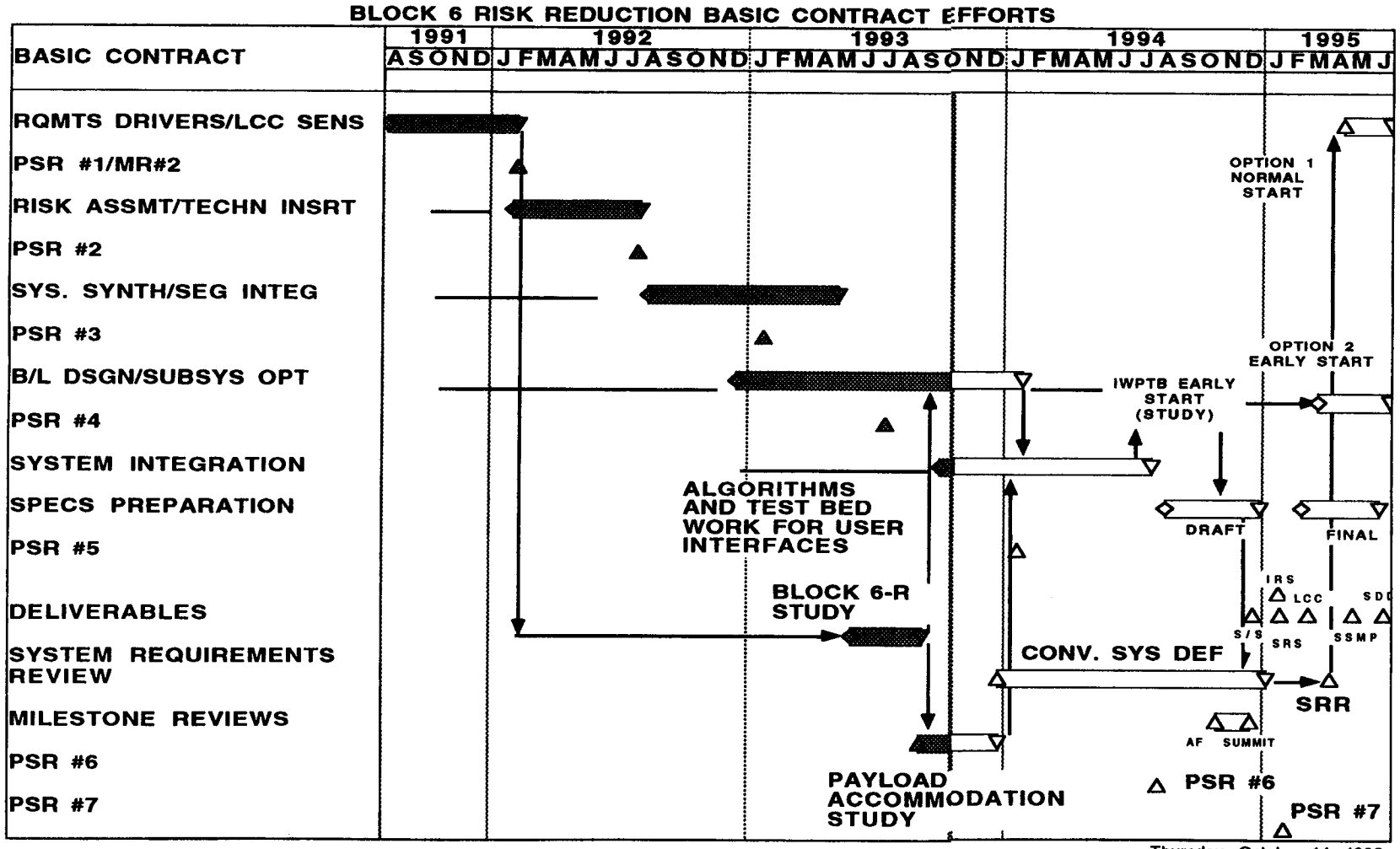
- INVESTING WISELY
- NO OVERRUNS
- SUBMIT DELIVERABLES EARLY
- BE RESPONSIVE AND FLEXIBLE
- IDENTIFY PROBLEMS EARLY
- CLOSE ACTIONS THOROUGHLY
- NO SURPRISES

ORIGINAL BASIC CONTRACT SCHEDULE

BLOCK 6 RISK REDUCTION BASIC CONTRACT EFFORTS



REVISED BLOCK 6 CONVERGENCE



Thursday, October 14, 1993

TASKS / ACTIONS FROM TIM #1

- O DETERMINATION OF DETAILED FIELDS OF VIEW
- O SPECIFICATION OF THE CORRECT I/F DOCUMENTS
- O CORRECTION OF SOME DATA RATES FOR OMIS AND NOAA
- O ADD END-TO-END C3 CONSIDERATIONS
- O PROVIDE ADDITIONAL DISCUSSION ON SUBCONTRACTOR APPROACH AND EXPERTISE
- O DISCUSS CALIBRATION REQUIREMENTS/APPROACH FOR OMIS
- O NEED TO CLARIFY THE MISS/MIMR RESOLUTION VALUES
- O AGREED TO STUDY RISK, C3, RFI, COSTING, AVAILABILITY
- O AGREED TO USE THE "REQUIREMENTS ISSUE" APPROACH

USING THE WINGED BUS PERMITS LAUNCHING ALL PAYLOADS (EXCEPT B3) UP TO ALTITUDES OF 450 TO 650 NMI

REQUIREMENTS ISSUE #1

CCSDS DATA FORMATTING ISSUE

ISSUE

- All new NASA (EOS) & NOAA programs require command and sensor data formats conform to Consultative Committee for Space Data Systems (CCSDS).
- Format is defined in GSFC interface documentation GSFC S-480-053.
- NOAA and EOS sensors, currently being developed, have adopted CCSDS as the standard for commands, telemetry, and stored data. This requirement constrains all sensors to a common 16 bit data packetized output.

IMPACTS

- CCSDS format increases total sensor data stream.
- If this standard is not adopted for DoD sensors, or relaxed by NOAA / EOS, a dual data bus approach to accommodate two data formats is needed.
- CCSDS impacts ability to compress data, data storage capacity, data rates, and minimum contact time required.

ACTIONS CONTINUED

- ALL ACTIONS REQUESTED FROM TIM #1 HAVE BEEN COMPLETED OR ARE BEING REPORTED ON AT THIS MEETING
- PAYLOAD CONFIGURATIONS NEED TO BE FEWER, -- CONTRACTORS CAN UPGRADE DETAILS
- BIGGEST RISK CONTINUES TO BE END-TO-END SYSTEM ARCHITECTURE WITH PAYLOAD CONSTRAINTS PRESENTLY IDENTIFIED
- PRIME CONTRACTING STILL AN IMPORTANT VALUE-ADDED FOR JOINT SPO APPROACH
- UPCOMING TASKS INCLUDE TIM #2 ACTION RESOLUTION AND MORE C3, RELIABILITY, SYSTEM ANALYSIS DETAILED COSTING WITH CLEAR BASELINES

ISSUES

- O TECHNOLOGY
- O TRANSITION
- O OPERATIONS CONCEPTS
- O NAVY PARTICIPATION (ESP. ALTIMETER)
- O SURVIVABILITY
- O CONVERGED SYSTEM NEED DATE / SCHEDULES
- O TASK STUDY SCHEDULES
- O [redacted] APPROACH
- O [redacted] FAMILY

RECOMMENDED APPROACH

1-- INDUSTRY PROPOSES *SYSTEM* SOLUTIONS TO INSTRUMENT AND SPACECRAFT CHALLENGES

--BETTER TECHNOLOGY
--WITH LOWER LIFE CYCLE COST
--LONGER LIFE, AND DATA CONTINUITY

2-- GOVERNMENT ADDS BASELINE COST INFORMATION AND DEVELOPS OPTIONS SCENARIOS

3-- NOAA and DMSP PROGRAMS QUANTIFY "IMPACTS" OF USING THE STRAWMAN SYSTEM(S)

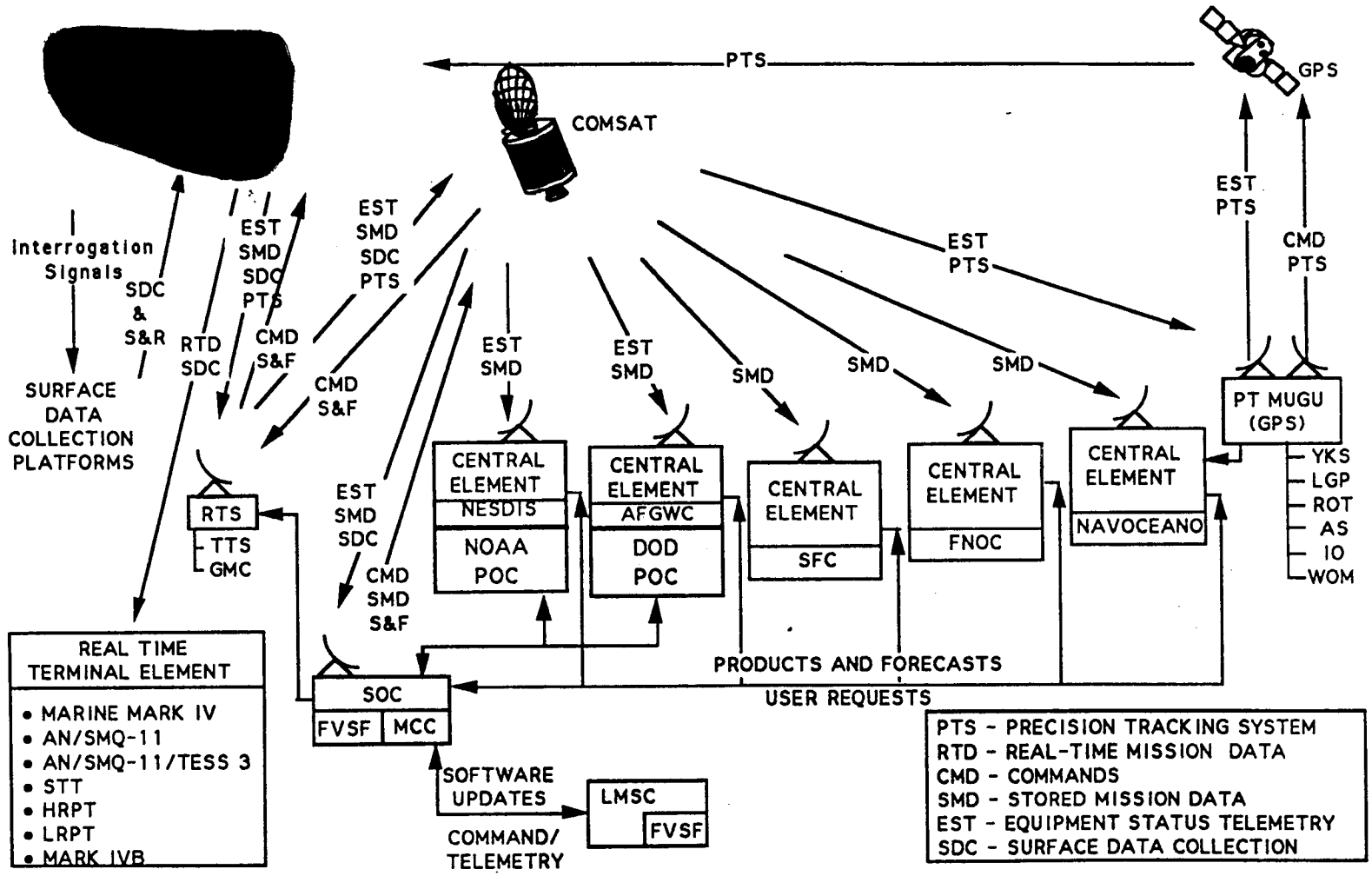
4-- INDUSTRY REFINES TECHNICAL SOLUTIONS AND PROVIDES COST ESTIMATES--WITH OPTIONS

5--GOVERNMENT *COMPETES* FOR MOST COST EFFECTIVE REVISED PROGRAM(S)--WITH OPTIONS

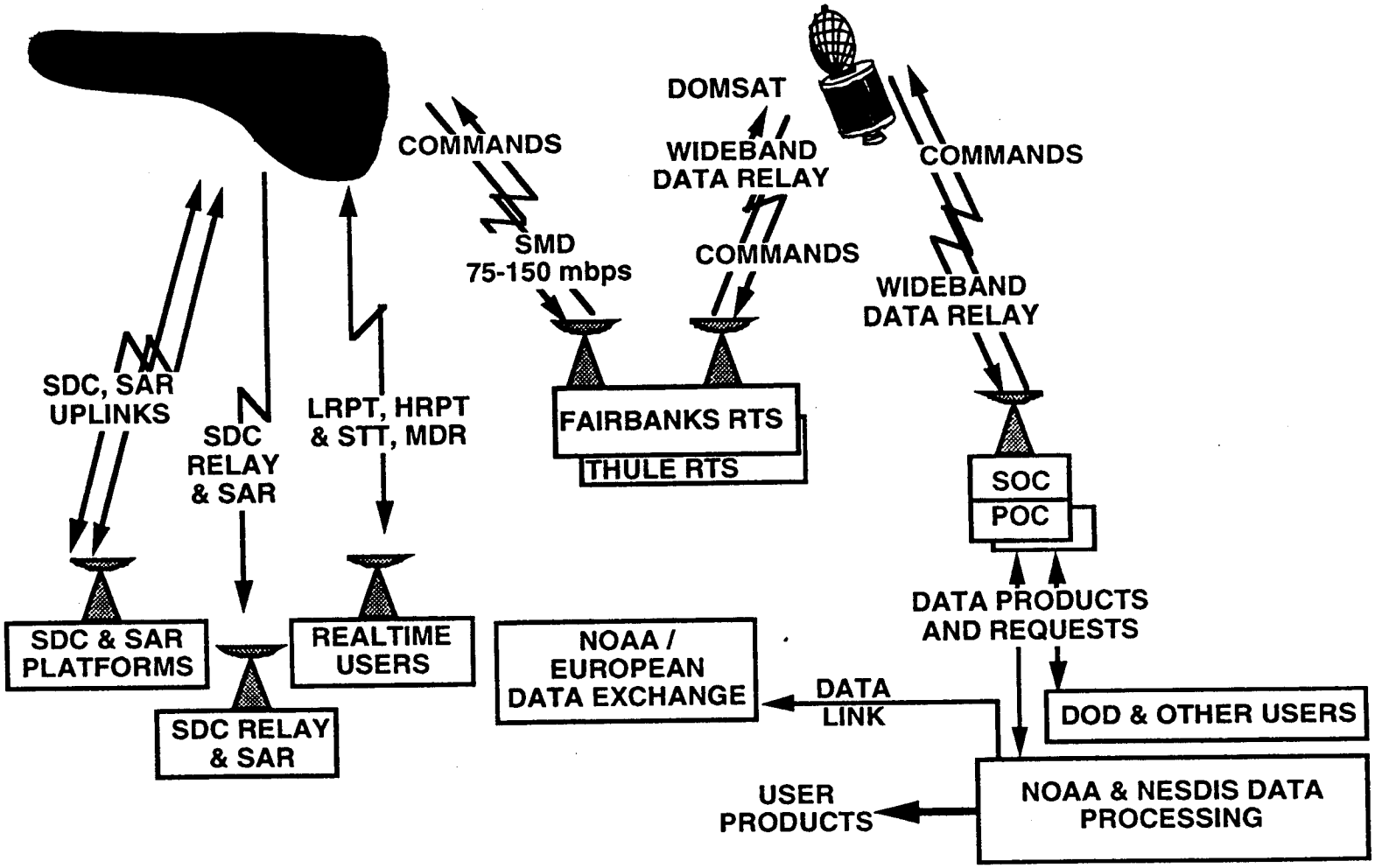
6--BEGIN NOW TO ENSURE DATA CONTINUITY

-INDUSTRY IS READY, SOLUTIONS EXIST

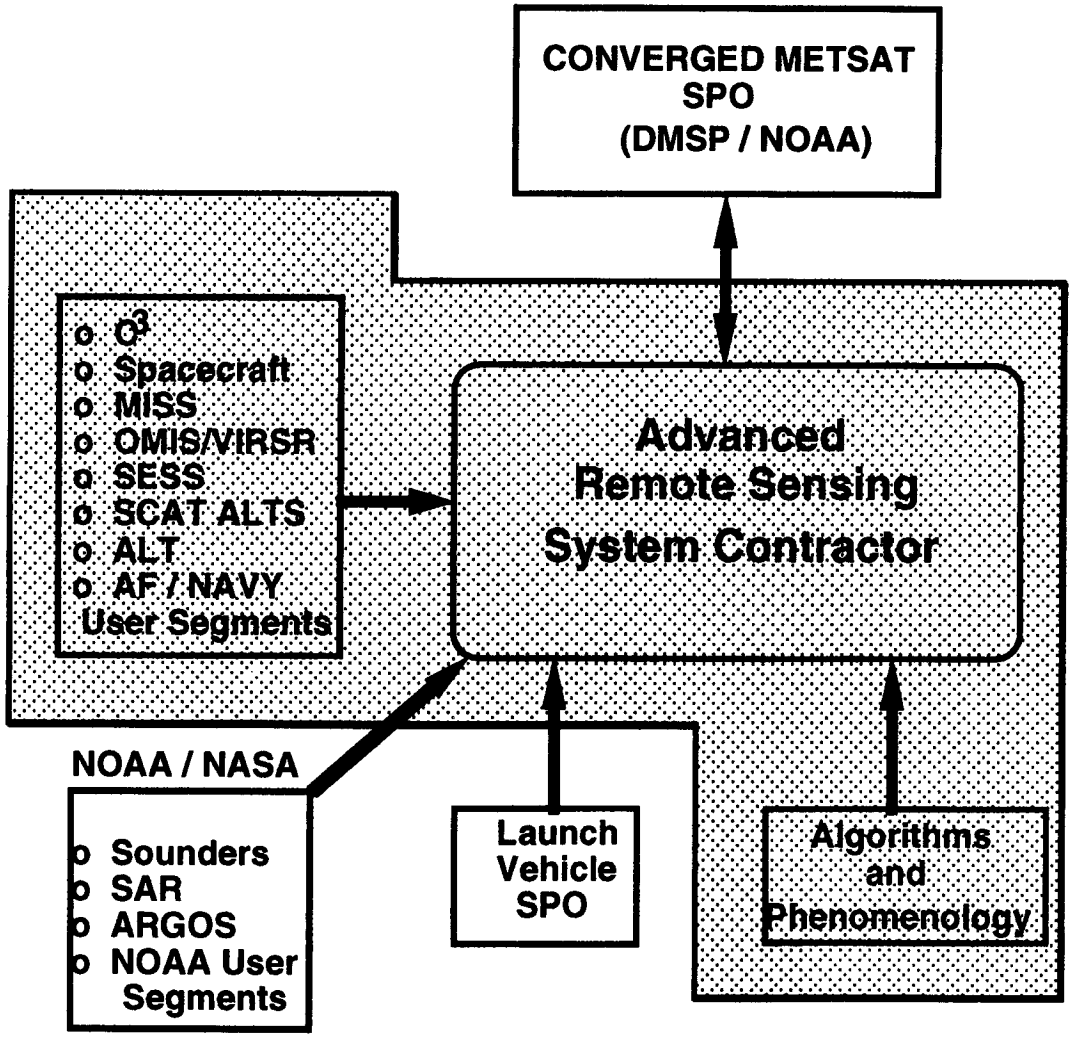
CONVERGED SYSTEM CONCEPT



CONVERGED DATA ROUTING CONCEPT

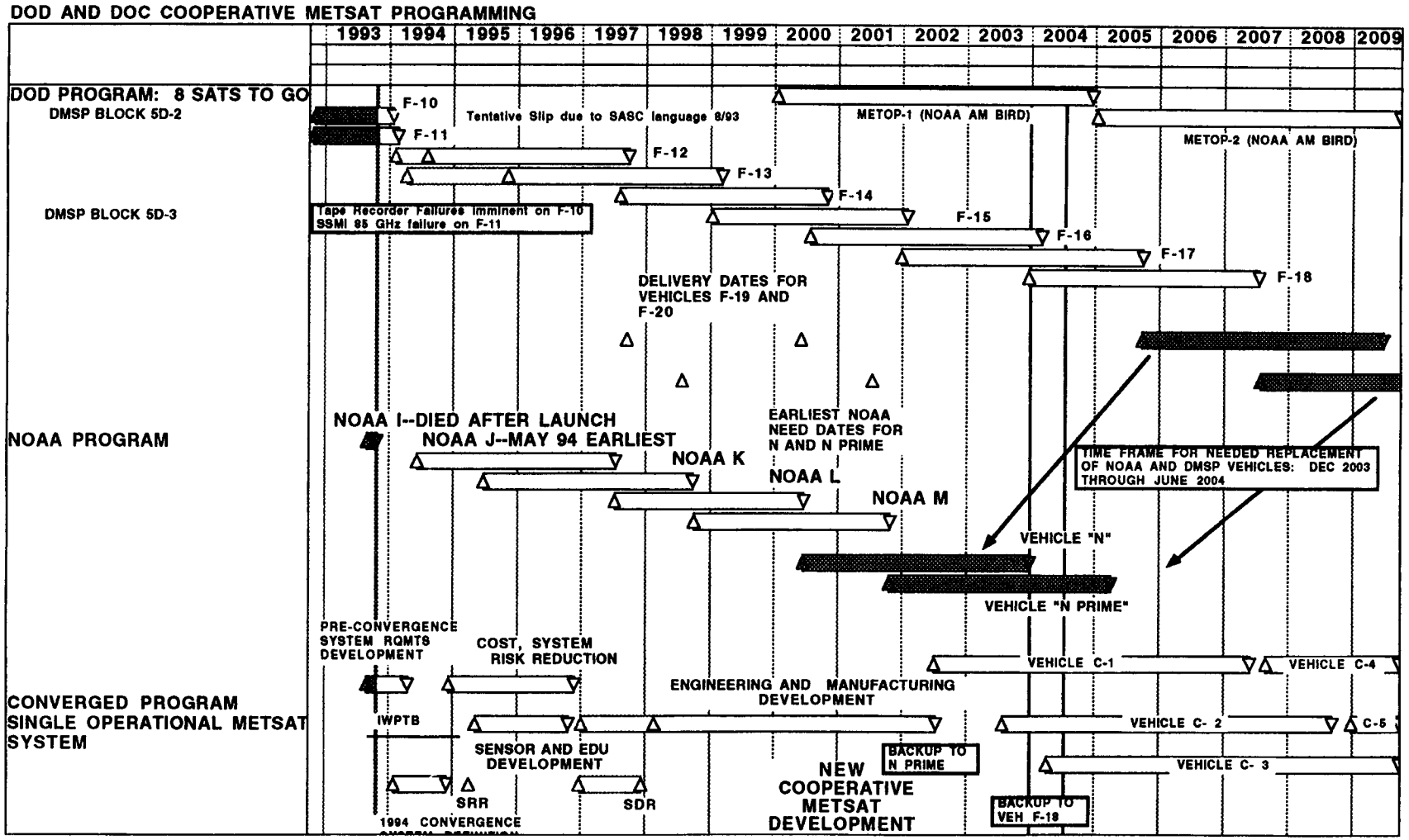


PRIME CONTRACTOR CONCEPT



- *o Assures Sensor and spacecraft optimum interface design*
- *o Retains Key End-to-End Systems Engineering Responsibility*
- *o Provides Cost Control (i.e. Lower LCC)*
- *o Insures Mission Data Requirements Are Met (i.e. EDRs)*
- *o Utilizes System Trade Data Developed on Block 6 Effort*
- *o Accommodates NOAA Sensors (GFE)*

NOAA AND DOD SCHEDULE DATES



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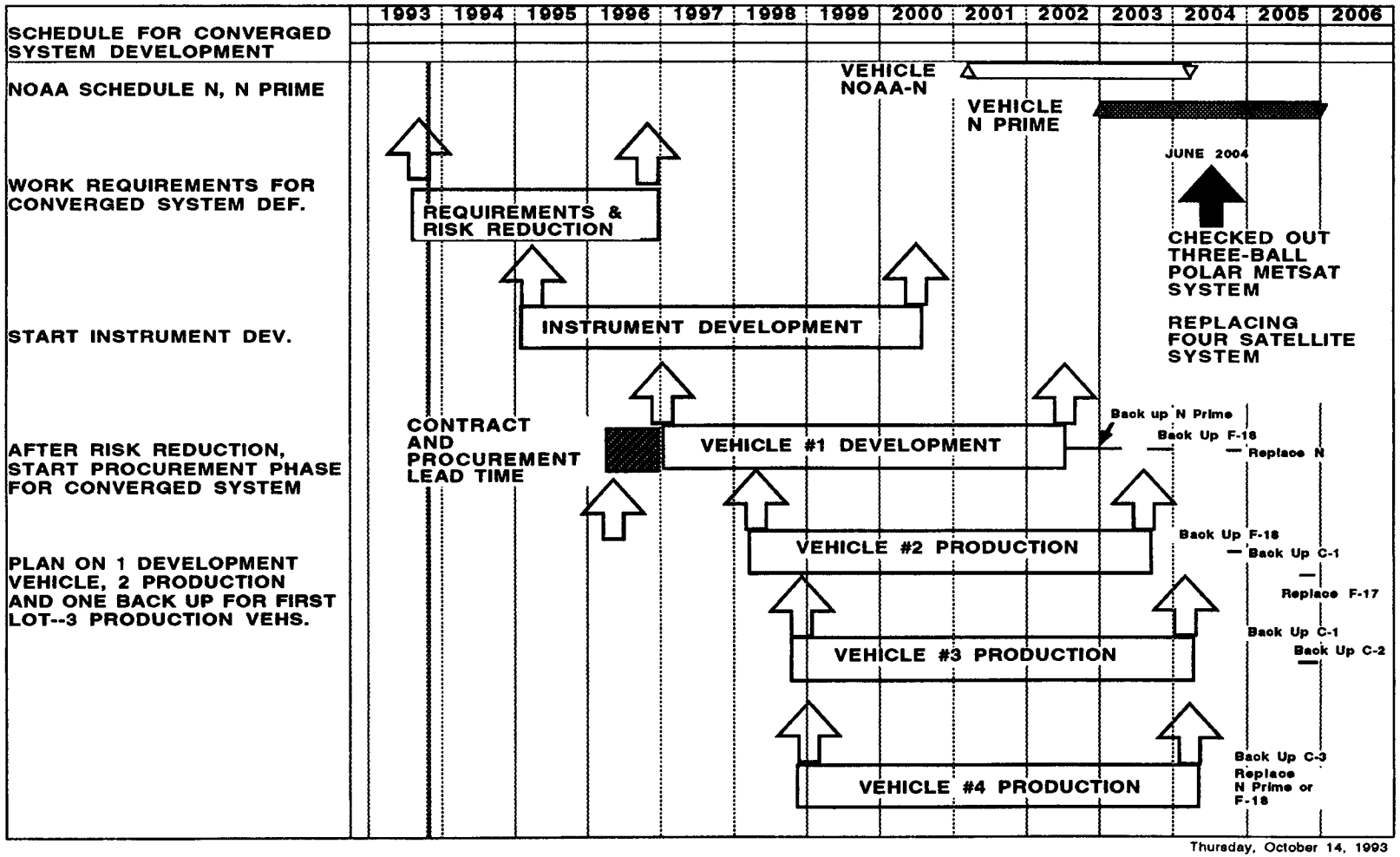
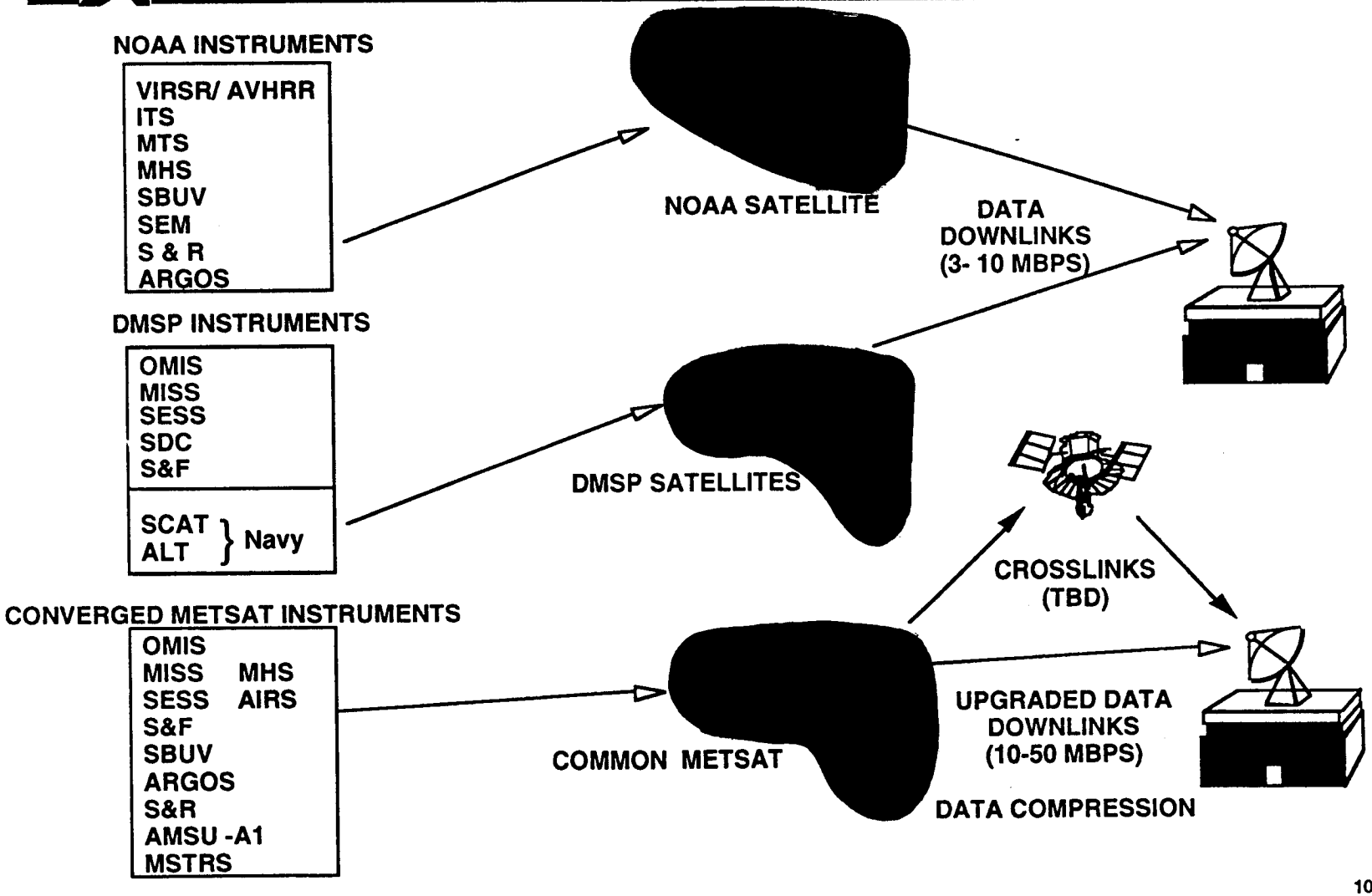
CONVERGED SYSTEM DEVELOPMENT



DMSP AND NOAA INTEGRATED SYSTEM



THE MILITARY REQUIREMENTS

"We are at a turning point with space. We have to make changes, get on with it. We have to make space efficient and responsive to wartime needs. We have to provide space data directly to the forces who are fighting the war."

GENERAL CHARLES A. HORNER, *AIR FORCE MAGAZINE*

APRIL 1993, PG 30.

ADDITIONAL MILITARY REQUIREMENTS INCLUDE A) DATA DENIAL CAPABILITY; B) FULL SWATH OF HIGH RESOLUTION IMAGERY, C) SURVIVABILITY FOR WAR FIGHTING

KEY ACTIONS FOR FY 94 AND 95

- O COMMIT TO A "SINGLE" DEVELOPMENT
- O FUND TRADE STUDIES AND CONSTELLATION DESIGN THROUGH IN-PLACE CONVERGENCE STUDY
- O PREPARE FOR A CONVERGED SYSTEM RISK REDUCTION DEVELOPMENT CONTRACT IN FY 95
- O SEPARATE SCIENCE (EOS) PAYLOADS FROM OPERATIONAL MISSIONS (DOD/NOAA)
- O RETAIN PRIME CONTRACTOR APPROACH FOR HARDWARE DEVELOPMENT
- O RECOGNIZE AND INCORPORATE METHOD TO MEET KEY MILITARY REQUIREMENTS
  - --ENCRYPTION --ORBIT SELECTION
  - --RESOLUTION
- O COMPLETE VIRSR PHASE "B" (JAN. 94) FOLD IN COST DATA TO OMIS DEVELOPMENT

PAGE 22 IS EXEMPT FROM RELEASE AND IS REPLACED WITH THIS PAGE.

[redacted] BUS HERITAGE

- BUS - 7 YEAR DESIGN LIFE
- 3 SIGMA POINTING
  - KNOWLEDGE < 0.01 DEG
  - CONTROL <0.02 DEG
- NO SINGLE POINT FAILURES
- MLV LAUNCH
- ORBIT ADJUST CONTROL

- LARGE SENSOR FOV AREA
- MODULAR SENSOR GROWTH
- NAVY OPTION PROVISIONS
- SENSOR / SC ENGINEERING

PAGES 24 THROUGH 26 ARE EXEMPT FROM RELEASE AND ARE REPLACED WITH THIS PAGE.

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RISK SUMMARY

- O SENSOR DEVELOPMENT RISK-- "LESSONS LEARNED"
  - -- MAKE EFFECTIVE USE OF EDU'S
  - -- STRONG "SENSOR-SMART" PRIME NEEDED
- O DATA PROCESSING AND RETRIEVAL RISK
  - -- 43-172 GBITS PER ORBIT DRIVE DOWNLINKS
  - -- MAKE EFFECTIVE USE OF DATA COMPRESSION
  - --ON-BOARD SOLID STATE MEMORY TECHNOLOGY
  - --END-TO-END USER DATA PROCESSING ALGORITHMS
- O DATA RECOVERY FROM RTS'S
  - -- END-TO-END PROCESSING ISSUE
  - -- USE DATA COMPRESSION
- O SENSOR COMPLEMENTS-- SENSOR CONSTRAINTS
  - -- VIRSR / EUMETSAT / SIZE ENVELOPE
  - -- DOES THAT DRIVE THE CONVERGED OMIS
- O SURVIVABILITY--A POTENTIAL COST RISK

SUMMARY

- "CONVERGENCE" MAY NOT BE IN THE BEST INTERESTS OF ANY *SINGLE* AGENCY, BUT IS PROBABLY IN THE BEST INTERESTS OF THE COUNTRY.
- THEREFORE, LMSC SSD IS READY TO SUPPORT THE NATIONAL DECISION MAKING PROCESS FOR A STANDARDIZED OPERATIONAL METSAT SYSTEM
- *COMPETITION* FOR THE LOWEST COST APPROACH IS IN THE BEST INTERESTS OF BOTH THE INDIVIDUAL AGENCIES (DOD, NOAA) *AND* THE NATION.
- THE RESULTANT SYSTEM NEEDS A STRONG, END-TO-END PRIME CONTRACTOR WHO CAN ENGINEER COST SAVINGS THROUGHOUT THE SYSTEM.

PAYLOAD CONFIGURATION ANALYSIS

JOHN CLAPP

- SENSOR CHARACTERISTICS
- CONFIGURATION ANALYSIS
- LAYOUTS: SPACE, FOV'S (Science, Cal's, Thermal)
- SPACECRAFT IMPACTS
- RISK ASSESSMENT

SENSOR CHARACTERISTICS (SH 1 OF 2)

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
OMIS-DMSP B/L	1321	635	610	0.512	0.839	88	195	0.03	2800	±55.7 xtrk	w/o sunshade
OMIS-Optics/8	1321	635	610	0.512	0.839	89	230	0.03	4500	±55.7 xtrk	w/o sunshade
OMIS-Elect'r'x	760	410	200	0.062	0.312	32					
OMIS-Ps	300	200	200	0.012	0.060	11					
AVHRR/3	800	292	366	0.085	0.234	30	30	0.05	1200		
VIRSR	850	600	400	0.204	0.510	50	55	0.25	1044	+57, -75 xtrk	
MODIS	1121	1740	1213	2.366	1.951	278	240	0.03	6500	±58 xtrk	Data Rate 11M sun
MISS	510	510	510	0.533	0.260	100	175	0.05	37.3	±70az,+56el	& 2 M Dish (.4 CuM)
MIMR	1022	1600	2151	3.517	1.635	273	200	0.05	100	±80az,+46el	Dim's Stowed
CERES	590	570	700	0.235	0.336	45	50	0.03	10	±84 cone, +Z	
AMSU-A1	731	337	605	0.149	0.246	50	90	0.1	2.1	+50,-90 xtrk	
AMSU-A2	635	754	685	0.328	0.479	50	37	0.1	1.1	+50,-90 xtrk	
MHS-Sen & Electr	774	990	560	0.429	0.766	65	90	0.1	4.2	+50,-90 xtrk	
ITS	600	440	640	0.169	0.264	55	80	tbd	1200	+51, -73 xtrk	
AIRS	1397	775	762	0.825	1.083	165	265	0.2	1330	±55 xtrk	
IRTS	662	395	305	0.080	0.261	55	60	0.1	3.5	+50, -75 xtrk	
SBUV-Sensor	370	325	610	0.073	0.120	50	25		0.38	±6 nadir	
SBUV-Elect	245	341	365	0.030	0.084	0	0				
TOMS	500	500	610	0.153	0.250	30	25	0.05	0.54	±54 xtrk	
HIRS/3	662	295	305	0.060	0.195	40	40	0.1	2.9	+50, -72 xtrk	

SENSOR CHARACTERISTICS (SH 2 OF 2)

SESS:											
AVM	164	141	52	0.001	0.023	10	1	N/A	0.24	in-situ	w/o Sensor Boom *
ABIS-UV	250	560	330	0.046	0.140	8	7	0.1	3	±50 xtrk	
RPA	230	250	250	0.014	0.058	11	11	0.1	2	±60,vel vect	w/o grd plane *
GPS-Rcvr	250	225	120	0.007	0.056	4	6	0.3	2	omni	w/o antennas *
GPS-Process	170	100	70	0.001	0.017	3	6	0	0		
DOS	203	140	312	0.009	0.028	6	6	N/A	0.27	omni	
NADIS	467	300	330	0.046	0.140	8	7	0.1	1	earth limb	
MEPS	222	146	152	0.005	0.032	4	5	0.1	1.2	8x128,zenith	
SEM											
TED	207	340	205	0.014	0.070	6.7	0		0.16	~ 4-15's	Pwr incl in DPU
MEPED	305	140	275	0.012	0.043	10.8	0		0	±60-Z,4-30's	Pwr incl in DPU
LEFI	317	348	492	0.054	0.110	8.4	10.8		0.38	unob hemis -X,+Y	
DPU	315	300	90	0.009	0.095	5.3	23		0.16		
S&R-RPU(2)	195	365	280	0.020	0.071	31.2	22.8				
S&R-SPU	195	310	280	0.017	0.060	14.4	6				
S&R-Rcvr	458	458	152	0.032	0.210	15.2	21			omni	w/o antennas *
S&R-Xmit	350	370	115	0.015	0.130	15.2	39			omni	w/o antennas *
ARGOS-RPU	195	365	280	0.020	0.071	16.8	25.2		2.56	omni	w/o antennas *
ARGOS-SPU(2)	195	310	280	0.034	0.121	31.2	7.2				
ARGOS-DCSR	195	310	280	0.017	0.060	18	30				
MSTRS-RCVR	76	127	102	0.001	0.010						
MSTRS-XMT/PROC	127	178	127	0.003	0.023	5	20	N/A	0		
MSTRS-SENSOR	152	152	152	0.004	0.023						
SDC-Rcvr (2)	254	254	228	0.029	0.129	22	15	N/A	1		
SDC-Xmtr (2)	178	178	64	0.004	0.063	5	2				
SDC-Proc/Intrgtr	406	254	228	0.024	0.103	27	20				
SDC-Ant	80	80	950	0.006	0.006	6				omni	

PAYLOAD CONFIGURATIONS (A THRU C)

			UNIQUE CONFIGURATIONS A THRU C										
CONFIGURATION	DMSP BLK6	NOAA OPQ'	A1	A2	A3	A4	B1	B2	B3	C1	C2	C3	C4
SENSOR						EOS PM							(G4)
OMIS-DMSP B/L	X												
OMIS-8 / VIRSR			X	X	X		X	X	X	X	X	X	
AVHRR/3													
VIRSR		X											
MODIS						X			X				X
MISS	X		X	X	X		X	X	X	X	X	X	
MIMR						X							X
CERES						X			X				X
AMSU-A1		X	X	X	X	X	X	X	X	X	X	X	
AMSU-A2		X				X							
MHS (S&E)		X	X	X	X	X	X	X	X	X	X	X	
ITS			X		X								
AIRS		X				X	X		X	X		X	
IRTS		X											
SBUV(S&E)		X			X				X			X	
TOMS		X											
SESS	X		X	X	X		X	X	X	X	X	X	
SEM		X											
S & R		X	X	X	X		X	X	X	X	X	X	
ARGOS		X	X	X	X		X	X	X	X	X	X	
MSTRS	X		X	X	X		X	X	X	X	X	X	
SDC	X												
IASI													
LAUNCH VEHICLE	D	D	D	D	D	A	D	D	A	D	D	D	D

PAYLOAD CONFIGURATIONS (G THRU I)

UNIQUE CONFIGURATIONS G THRU I
EUM NOT REQUIRED

G1	G2	G3	G4	G5	H1	H2	H3	H4	I1	I2	I3	I4	I5	CONFIGURATION
				EUM				EUM					EUM	SENSOR
														OMIS-DMSP B/L
X	X	X		X	X	X	X	X	X	X	X		X	OMIS-8 / VIRSR
														AVHRR/3
														VIRSR
			X				X					X		MODIS
X	X	X			X	X	X		X	X	X			MISS
			X											MIMR
			X				X					X		CERES
		X		X			X	X	X		X	X	X	AMSU-A1
				X				X				X	X	AMSU-A2
		X		X			X	X	X		X	X	X	MHS (S&E)
									X		X			ITS
		X					X					X		AIRS
														IRTS
		X					X				X			SBUV(S&E)
														TOMS
X	X				X	X			X	X	X			SESS
				X				X					X	SEM
		X		X			X	X	X	X	X		X	S & R
		X		X			X	X	X	X	X		X	ARGOS
X	X				X	X			X	X	X			MSTRS
														SDC
				X				X					X	IASI
D	D	D	D		D	D	A		D	D	D	D		

P/L CONFIGURATION ANALYSIS

CONFIG ID	UNIQUE PRODUCT	IDENTICAL TO	UNIQUE OR 1ST USAGE	COMMENT (NR-NOT REQD)	PRIMARY (NEW) CONFIGURATIONS	BASIC CONFIGURATIONS
A1	5.7793E+12	I1	X	= A3 LESS SBUV		CONFIG A - SAME AS
A2	1.8643E+11	B2,C2	X	= A1 LESS ITS		CONFIG C, EXCEPT ITS
A3	2.4851E+14	I3	X		X	REPLACES AIRS
A4	7.2539E+08		X	EOS PM - NR		
B1	6.8979E+12	C1	X	= C3, LESS SBUV		
B2	1.8643E+11	A2,C2				
B3	3.5296E+16		X	ATLAS SHROUD	X	X
C1	6.8979E+12	B1				
C2	1.8643E+11	A2,B2				
C3	2.9661E+14		X		X	X
C4	1.5470E+03	G4		DEFER TO G4		
G1	8.2786E+04	G2,H1,H2	X	= DMSP B/L		
G2	8.2786E+04	G1,H1,H2				
G3	7.8822E+10		X		X	= C3, LESS MSTRS,SESS
G4	1.5470E+03	C4	X		X	X
G5	4.8283E+11	H4,I5	X	EUM - NR		
H1	8.2786E+04	G1,G2,H2				
H2	8.2786E+04	G1,G2,H1				
H3	9.3799E+12		X	ATLAS SHROUD	X	= B3, LESS MSTRS,SESS
H4	4.8283E+11	G5,I5				
I1	5.7793E+12	A1				
I2	3.3835E+08		X		X	= DMSP + S&R, ARGOS
I3	2.4851E+14	A3				
I4	5.5799E+07		X		X	X
I5	4.8283E+11	G5,H4				

DMSP/POES CONVERGENCE STUDY

P/L UNIQUE CONFIG COMPARISONS - ALL

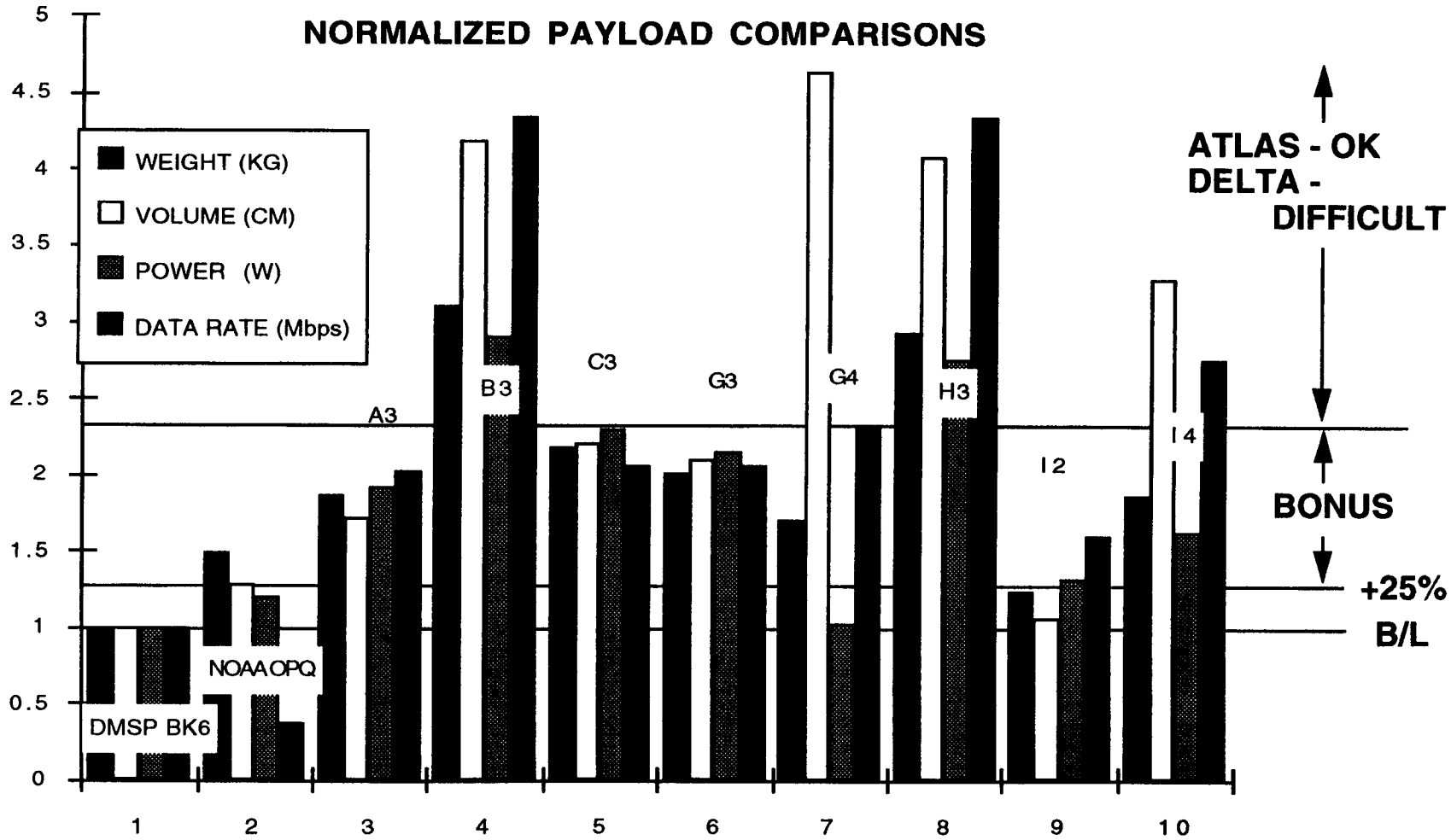
CONFIGURATION	DMSP BLK6	NOAA OPQ'	A1	A2	A3	B1	B3	C3	G1	G3	G4	H3	I2	I4
SENSOR														
OMIS-DMSP B/L	X													
OMIS/8			X	X	X	X	X	X	X	X		X	X	
AVHRR/3														
VIRSR		X												
MODIS							X				X	X		X
MISS	X		X	X	X	X	X	X	X	X		X	X	
MIMR											X			
CERES							X				X	X		X
AMSU-A1		X	X	X	X	X	X	X		X		X		X
AMSU-A2		X												X
MHS (S&E)		X	X	X	X	X	X	X		X		X		X
ITS			X		X									
AIRS						X	X	X		X		X		X
IRTS		X												
SBUV(S&E)		X			X		X	X		X		X		
TOMS		X												
SESS	X		X	X	X	X	X	X	X				X	
SEM		X												
S & R		X	X	X	X	X	X	X		X		X	X	
ARGOS		X	X	X	X	X	X	X		X		X	X	
MSTRS	X		X	X	X	X	X	X	X				X	
SDC	X													
WEIGHT (KG)	350	523	603	548	653	713	1086	763	291	704	596	1027	433	653
VOLUME (CM)	1.32	1.69	2.16	1.99	2.26	2.81	5.52	2.92	1.26	2.78	6.12	5.38	1.41	4.33
POWER (W)	476	567	885	805	910	1070	1385	1095	474	1026	490	1316	625	772
DATA RATE (Mbps)	2.85	1.06	5.76	4.56	5.76	5.89	12.40	5.89	4.55	5.88	6.61	12.39	4.55	7.85

P/L UNIQUE CONFIG COMPARISONS - PRIMARY

CONFIGURATION	DMSP BLK6	NOAA OPQ'	A3	B3	C3	G3	G4	H3	I2	I4
SENSOR										
OMIS-DMSP B/L	X									
OMIS/8			X	X	X	X		X	X	
AVHRR/3										
VIRSR		X								
MODIS				X			X	X		X
MISS	X		X	X	X	X		X	X	
MIMR							X			
CERES				X			X	X		X
AMSU-A1		X	X	X	X	X		X		X
AMSU-A2		X								X
MHS (S&E)		X	X	X	X	X		X		X
ITS			X							
AIRS				X	X	X		X		X
IRTS		X								
SBUV(S&E)		X	X	X	X	X		X		
TOMS		X								
SESS	X		X	X	X				X	
SEM		X								
S & R		X	X	X	X	X		X	X	
ARGOS		X	X	X	X	X		X	X	
MSTRS	X		X	X	X				X	
SDC	X									
WEIGHT (KG)	350	523	653	1086	763	704	596	1027	433	653
VOLUME (CM)	1.32	1.69	2.26	5.52	2.92	2.78	6.12	5.38	1.41	4.33
POWER (W)	476	567	910	1385	1095	1026	490	1316	625	772
DATA RATE (Mbps)	2.85	1.06	5.76	12.40	5.89	5.88	6.61	12.39	4.55	7.85

DMSP/POES CONVERGENCE STUDY

P/L UNIQUE CONFIG COMPARISONS - PRIMARY GRAPH



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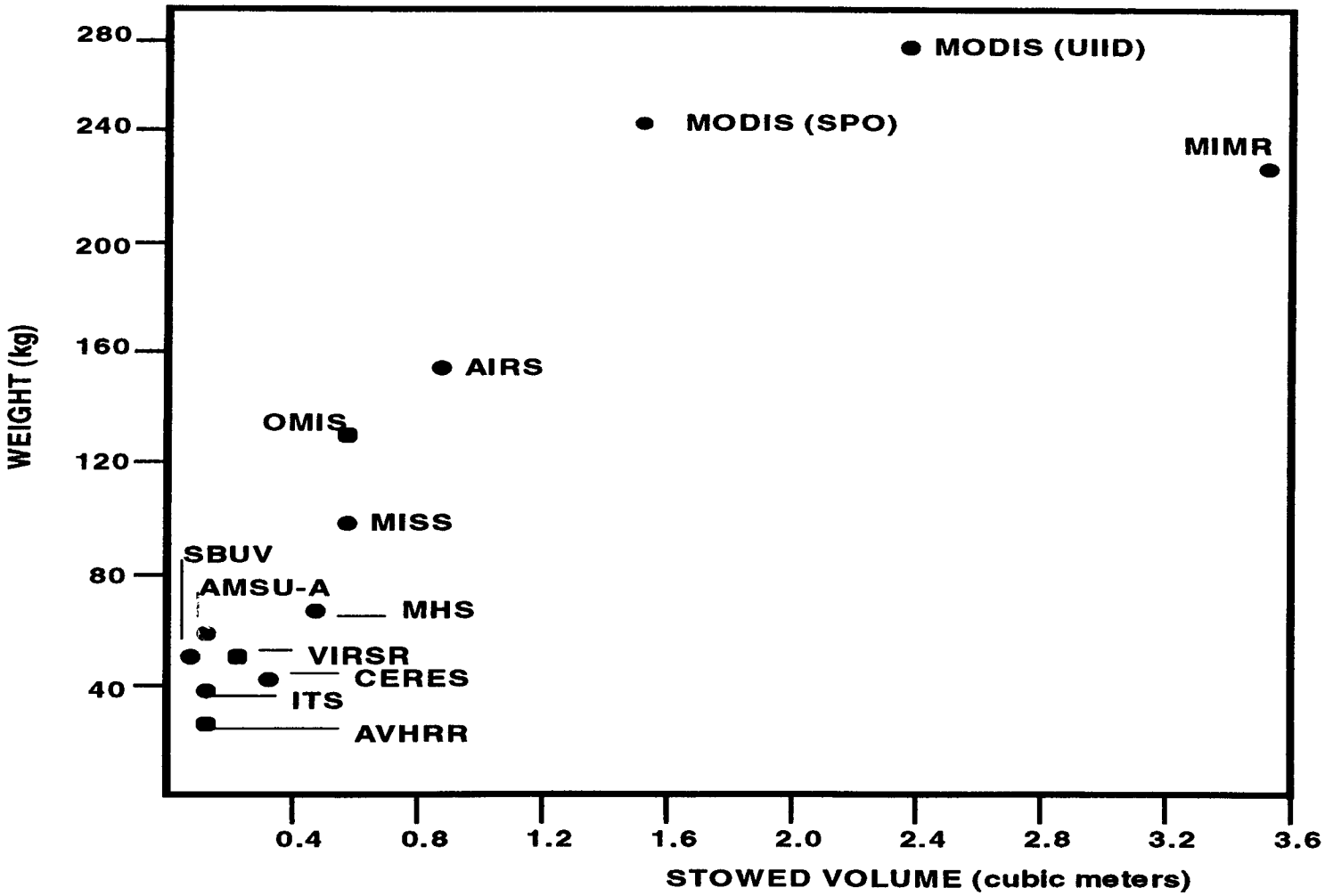
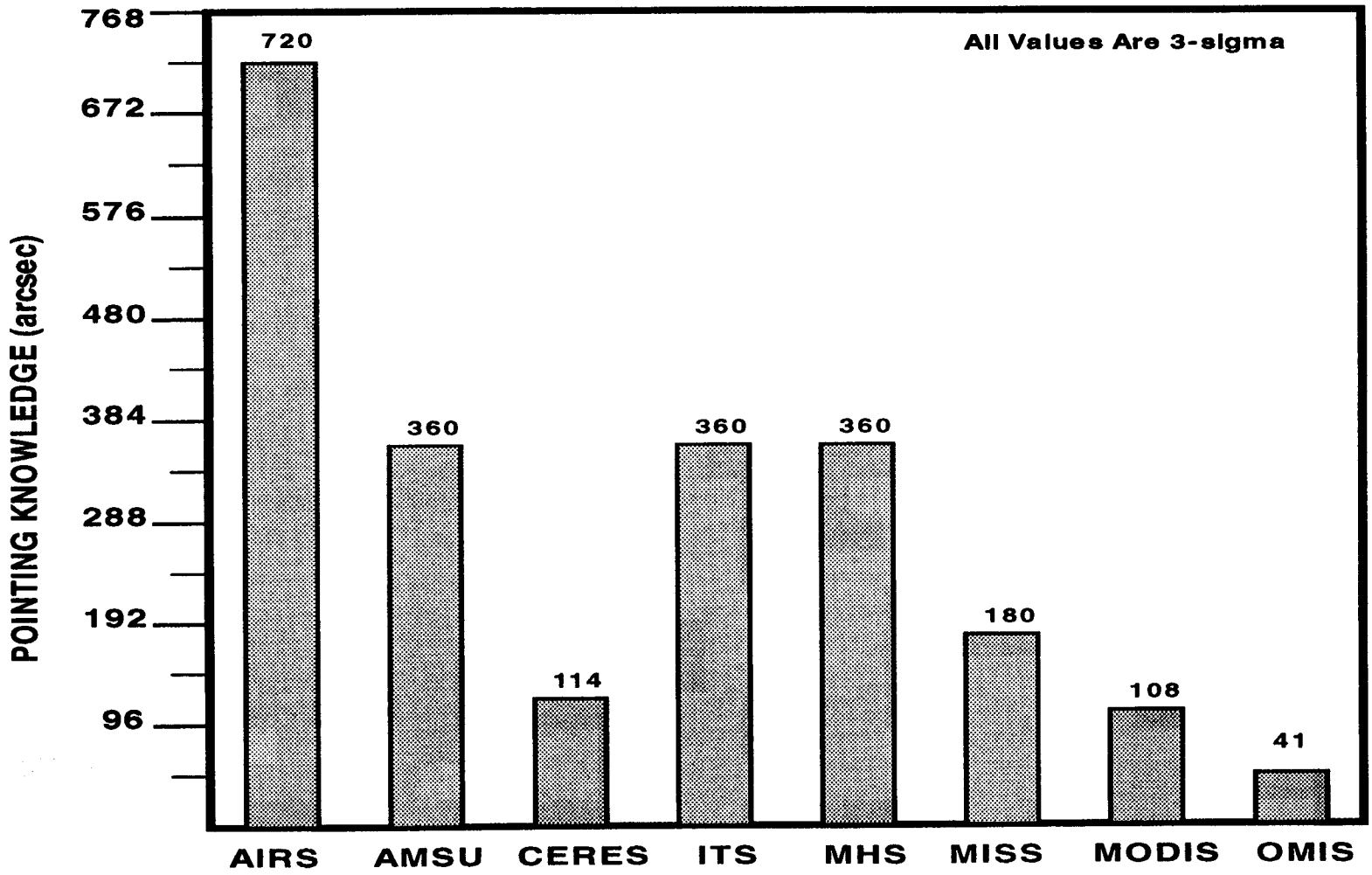
SENSOR VOLUME AND WEIGHT COMPARISON

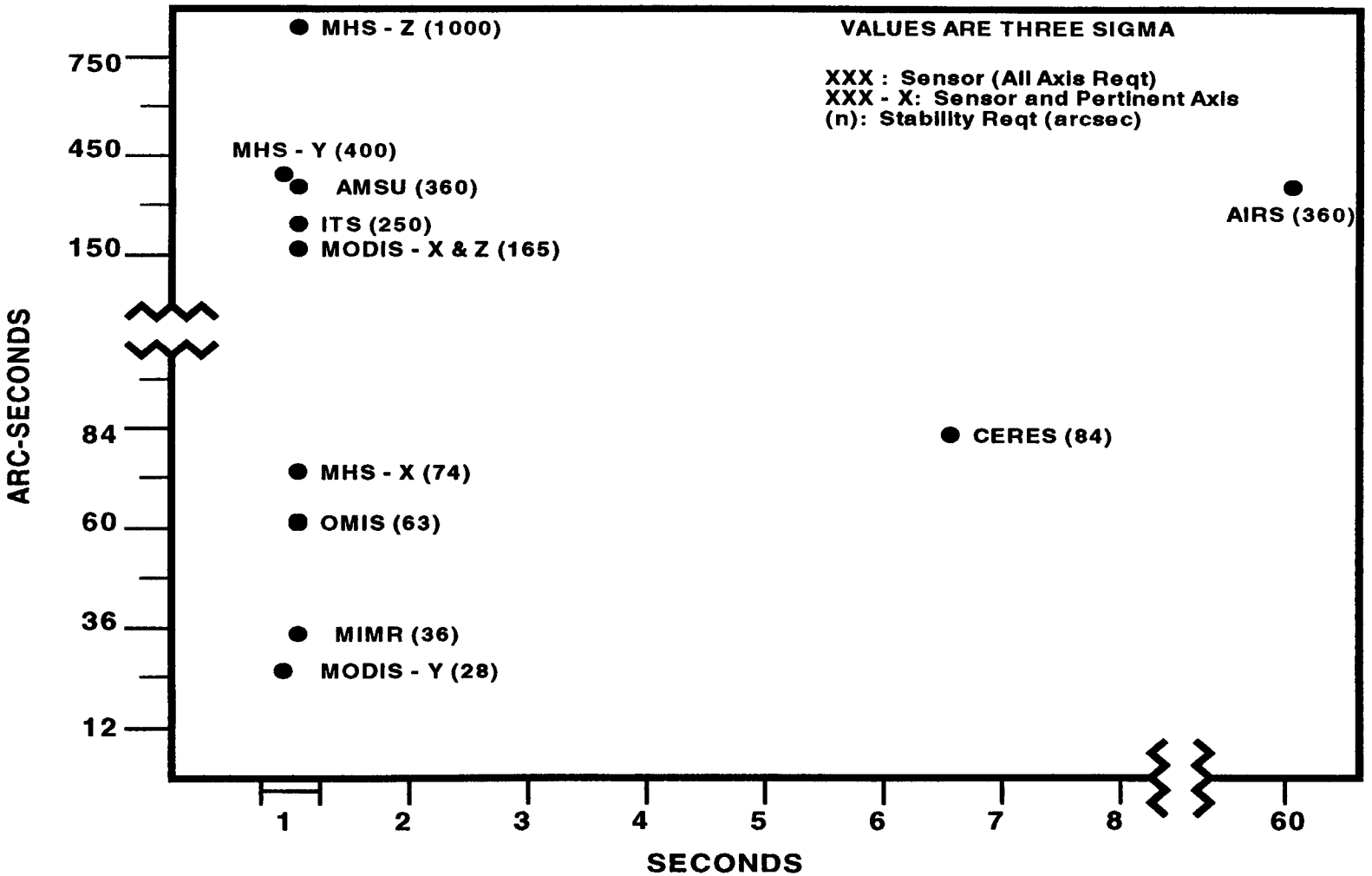


SENSOR POINTING KNOWLEDGE REQUIREMENTS



DMSP/POES CONVERGENCE STUDY

SENSOR POINTING STABILITY REQUIREMENTS



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PAGE 41 IS EXEMPT FROM RELEASE AND IS REPLACED WITH THIS PAGE.

P/L ACCOMMODATIONS SUMMARY - A3

CATEGORY [1]	P/L DELTA [2]	S/C SIZING	CAPABILITY [5]	RISK [3]
S/C WEIGHT	+87%	2193 KG	2700 KG	LOW
S/C POWER LOAD	+91%	1833 W	2.2/3.0 KW [4]	LOW
SOLAR ARRAY (BOL)	368 Sq Ft, Si	4.41 KW	5.4/7.3 KW [4]	LOW
DATA RATE	+102%	5.89 MBPS	C3/GRD	MEDIUM
FOV & SPACE	+71%	~75%	100%	LOW

RISK ASSESSMENT - MEDIUM. DATA RATE INCREASE DUE TO OMIS & ITS HAS A SIGNIFICANT IMPACT ON DATA HANDLING SIZING.

1. WITH CONTINGENCY, BUT NO GROWTH
2. PAYLOAD COMPARISON AGAINST DMSP B/L P/L'S
3. RELATIVE TO OTHER CONVERGENCE CONFIGURATIONS
4. SOLAR CELLS - SILICON OR GALIUM ARSENIDE (Si/GaAs)
5. Derated to 85%

PAGE 43 IS EXEMPT FROM RELEASE AND IS REPLACED WITH THIS PAGE.

P/L ACCOMMODATIONS SUMMARY - B3

CATEGORY [1]	P/L DELTA [2]	S/C SIZING	CAPABILITY	RISK [3]
S/C WEIGHT (Gr/Ep)	+210%	3236 KG	4400 KG	LOW
S/C POWER LOAD	+191%	2444 W	2.2/3.0 KW [4]	MEDIUM
SOLAR ARRAY (BOL)	477 Sq Ft, Si	5.88 KW	5.4/7.3 KW [4]	MEDIUM
DATA RATE	+335%	12.4 MBPS	C3/GRD	HIGH
FOV & SPACE	+318%	~ 99%	100%	HIGH

RISK ASSESSMENT - HIGH/MEDIUM. MANY LARGE & MEDIUM P/L'S FILL BUS/SIM TO CAPACITY. FOV LIMITATIONS - OMIS, MODIS. SOLAR ARRAY REQUIRES GaAs CELLS. VERY HIGH DATA RATE HAS A MAXIMUM IMPACT ON DATA HANDLING SIZING.

1. WITH CONTINGENCY, BUT NO GROWTH
2. PAYLOAD COMPARISON AGAINST DMSP B/L P/L'S
3. RELATIVE TO OTHER CONVERGENCE CONFIGURATIONS
4. SOLAR CELLS - SILICON OR GALIUM ARSENIDE (Si/GaAs)

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P/L ACCOMMODATIONS SUMMARY - C3

CATEGORY [1]	P/L DELTA [2]	S/C SIZING	CAPABILITY	RISK [3]
S/C WEIGHT	+118%	2345 KG	2700 KG	LOW
S/C POWER LOAD	+130%	2046 W	2.2/3.0 KW [4]	LOW
SOLAR ARRAY (BOL)	411 Sq Ft, Si	4.92 KW	5.4/7.3 KW [4]	LOW
DATA RATE	+107%	5.89 MBPS	C3/GRD	MEDIUM
FOV & SPACE	+121%	~ 95%	100%	MEDIUM

RISK ASSESSMENT - MEDIUM. AIRS LARGE VOLUME SIGNIFICANTLY LIMITS EQUIPMENT LOCATION. DATA RATE INCREASE DUE TO OMIS & AIRS HAS A SIGNIFICANT IMPACT ON DATA HANDLING SIZING.

1. WITH CONTINGENCY, BUT NO GROWTH
2. PAYLOAD COMPARISON AGAINST DMSP B/L P/L'S
3. RELATIVE TO OTHER CONVERGENCE CONFIGURATIONS
4. SOLAR CELLS - SILICON OR GALIUM ARSENIDE (Si/GaAs)

PAYLOAD CONFIGURATION G3

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
OMIS-Optics/8	1321	635	610	0.5117	0.838835	89	230	0.03	4500	±55.7 xtrk	w/o sunshade
OMIS-Elect'r'x	760	410	200	0.0623	0.3116	32	0	0	0	0	0
OMIS-Ps	300	200	200	0.012	0.06	11	0	0	0	0	
MISS	510	510	510	0.5327	0.2601	100	175	0.05	37.3	±70az,+56el	& 2 M Dish (.4 CM)
AMSU-A1	731	337	605	0.149	0.246347	50	90	0.1	2.1	(+50,-90)	0
MHS-Sen & Electr	774	990	560	0.4291	0.76626	65	90	0.1	4.2	(+50,-90)	
AIRS	1397	775	762	0.825	1.082675	165	265	0.2	1330	±55 xtrk	0
SBUV-Sensor	370	325	610	0.0734	0.12025	50	25	0	0.38	±6 nadir	0
SBUV-Elect	245	341	365	0.0305	0.083545	0	0	0	0	0	
S&R-RPU(2)	195	365	280	0.0199	0.071175	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	0.209764	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	0.071175	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
Totals				2.780	4.493	704	1026		5876.5		

PAGES 48 THROUGH 50 ARE EXEMPT FROM RELEASE AND ARE REPLACED WITH THIS PAGE.

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P/L ACCOMMODATIONS SUMMARY - G3

CATEGORY [1]	P/L DELTA [2]	S/C SIZING	CAPABILITY	RISK [3]
S/C WEIGHT	+101%	2264 KG	2700 KG	LOW
S/C POWER LOAD	+116%	1967 W	2.2/3.0 KW [4]	LOW
SOLAR ARRAY (BOL)	395 Sq Ft, Si	4.73 KW	5.4/7.3 KW [4]	LOW
DATA RATE	+106%	5.88 MBPS	C3/GRD	MEDIUM
FOV & SPACE	+111%	~ 85%	100%	MEDIUM

RISK ASSESSMENT - MEDIUM. AIRS LARGE VOLUME SIGNIFICANTLY LIMITS EQUIPMENT LOCATION. DATA RATE INCREASE DUE TO OMIS & AIRS HAS A SIGNIFICANT IMPACT ON DATA HANDLING SIZING.

1. WITH CONTINGENCY, BUT NO GROWTH
2. PAYLOAD COMPARISON AGAINST DMSP B/L P/L'S
3. RELATIVE TO OTHER CONVERGENCE CONFIGURATIONS
4. SOLAR CELLS - SILICON OR GALIUM ARSENIDE (Si/GaAs)

PAYLOAD CONFIGURATION G4

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
MODIS	1121	1740	1213	2.366	1.95054	278	240	0.03	6500	±58 xtrk	Data Rate 11M sun
MIMR	1022	1600	2151	3.5173	1.6352	273	200	0.05	100	±80az,+46el	Dim's Stowed
CERES	590	570	700	0.2354	0.3363	45	50	0.03	10	±84 cone, +Z	0
Totals				6.119	3.922	596	490		6610		

PAGES 53 THROUGH 55 ARE EXEMPT FROM RELEASE AND ARE REPLACED WITH THIS PAGE.

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P/L ACCOMMODATIONS SUMMARY - G4

CATEGORY [1]	P/L DELTA [2]	S/C SIZING	CAPABILITY	RISK [3]
S/C WEIGHT	+70%	2114 KG	2700 KG	LOW
S/C POWER LOAD	+3%	1350 W	2.2/3.0 KW [4]	LOW
SOLAR ARRAY (BOL)	270 Sq Ft, Si	3.25 KW	5.4/7.3 KW [4]	LOW
DATA RATE	+132%	6.61 MBPS	C3/GRD	MEDIUM
FOV & SPACE	+364%	~ 203%	100%	HIGH

RISK ASSESSMENT - HIGH/MEDIUM. MODIS & MIMR VERY LARGE VOLUME TOTALLY LIMITS EQUIPMENT LOCATION IN DELTA SHROUD. FOV - SOME IMPAIRMENT. MODIS DATA RATE HAS A CONSIDERABLE IMPACT ON DATA HANDLING SIZING.

1. WITH CONTINGENCY, BUT NO GROWTH
2. PAYLOAD COMPARISON AGAINST DMSP B/L P/L'S
3. RELATIVE TO OTHER CONVERGENCE CONFIGURATIONS
4. SOLAR CELLS - SILICON OR GALIUM ARSENIDE (Si/GaAs)

PAYLOAD CONFIGURATION H3

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
OMIS-Optics/8	1321	635	610	0.5117	0.838835	89	230	0.03	4500	±55.7 xtrk	w/o sunshade
OMIS-Elect'r'x	760	410	200	0.0623	0.3116	32	0	0	0	0	0
OMIS-Ps	300	200	200	0.012	0.06	11	0	0	0	0	
MODIS	1121	1740	1213	2.366	1.95054	278	240	0.03	6500	±58 xtrk	Data Rate 11M sun
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
CERES	590	570	700	0.2354	0.3363	45	50	0.03	10	±84 cone, +Z	0
0	0	0	0	0	0	0	0	0	0	0	0
AMSU-A1	731	337	605	0.149	0.246347	50	90	0.1	2.1	+50,-90 xtrk	0
0	0	0	0	0	0	0	0	0	0	0	0
MHS-Sen & Electr	774	990	560	0.4291	0.76626	65	90	0.1	4.2	+50,-90 xtrk	
AIRS	1397	775	762	0.825	1.082675	165	265	0.2	1330	±55 xtrk	0
SBUV-Sensor	370	325	610	0.0734	0.12025	50	25	0	0.38	±6 nadir	0
SBUV-Elect	245	341	365	0.0305	0.083545	0	0	0	0	0	
S&R-RPU(2)	195	365	280	0.0199	0.071175	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	0.209764	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	0.071175	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
Totals				5.381	6.780	1027	1316		12387		

PAGES 58 THROUGH 61 ARE EXEMPT FROM RELEASE AND ARE REPLACED WITH THIS PAGE.

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P/L ACCOMMODATIONS SUMMARY - H3 ATLAS LAUNCH

CATEGORY [1]	P/L DELTA [2]	S/C SIZING	CAPABILITY	RISK [3]
S/C WEIGHT (Gr/Ep)	+193%	3177 KG	4400 KG	LOW
S/C POWER LOAD	+176%	2300 W	2.2/3.0 KW [4]	MEDIUM
SOLAR ARRAY (BOL)	461 Sq Ft, Si	5.54 KW	5.4/7.3 KW [4]	MEDIUM
DATA RATE	+335%	12.4 MBPS	C3/GRD	HIGH
FOV & SPACE	+308%	~ 98%	100%	HIGH

RISK ASSESSMENT - HIGH/MEDIUM. MANY LARGE & MEDIUM P/L'S FILL BUS/SIM TO CAPACITY. FOV LIMITATIONS - OMIS, MODIS. SOLAR ARRAY REQUIRES GaAs CELLS. VERY HIGH DATA RATE HAS A MAXIMUM IMPACT ON DATA HANDLING SIZING.

1. WITH CONTINGENCY, BUT NO GROWTH
2. PAYLOAD COMPARISON AGAINST DMSP B/L P/L'S
3. RELATIVE TO OTHER CONVERGENCE CONFIGURATIONS
4. SOLAR CELLS - SILICON OR GALIUM ARSENIDE (Si/GaAs)

PAYLOAD CONFIGURATION I2

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
OMIS-Optics/8	1321	635	610	0.5117	0.838835	89	230	0.03	4500	±55.7 xtrk	w/o sunshade
OMIS-Elect'r'x	760	410	200	0.0623	0.3116	32	0	0	0	0	0
OMIS-Ps	300	200	200	0.012	0.06	11	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)
SESS:											
AVM	164	141	52	0.0012	0.023124	10	1	N/A	0.24	in-situ	w/o 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
DOS	203	140	312	0.0089	0.02842	6	6	N/A	0.27	omni	
NADIS	467	300	330	0.0462	0.1401	8	7	0.1	1	earth limb	0
MEPS	222	146	152	0.0049	0.032412	4	5	0.1	1.2	8x128,zenith	0
S&R-RPU(2)	195	365	280	0.0199	0.071175	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	0.209764	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	0.071175	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
MSTRS-RCVR	76	127	102	0.001	0.009652	0	0	0	0	0	0
MSTRS-XMT/PROC	127	178	127	0.0029	0.022606	5	20	N/A	0	0	0
MSTRS-SENSOR	152	152	152	0.0035	0.023104	0	0	0	0	0	0
Totals				1.410	2.744	433	625		4549.6		

PAGES 64 THROUGH 66 ARE EXEMPT FROM RELEASE AND ARE REPLACED WITH THIS PAGE.

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P/L ACCOMMODATIONS SUMMARY - I2

CATEGORY [1]	P/L DELTA [2]	S/C SIZING	CAPABILITY	RISK [3]
S/C WEIGHT	+24%	1890 KG	2700 KG	LOW
S/C POWER LOAD	+31%	1505 W	2.2/3.0 KW [4]	LOW
SOLAR ARRAY (BOL)	302 Sq Ft, Si	3.62 KW	5.4/7.3 KW [4]	LOW
DATA RATE	+60%	4.55 MBPS	C3/GRD	MEDIUM
FOV & SPACE	+7%	~ 50%	100%	LOW

RISK ASSESSMENT - MEDIUM. DATA RATE INCREASE DUE TO OMIS RESOLUTION (12 BIT) & NO DATA COMPRESSION HAS A SIGNIFICANT IMPACT ON DATA HANDLING SIZING.

1. WITH CONTINGENCY, BUT NO GROWTH
2. PAYLOAD COMPARISON AGAINST DMSP B/L P/L'S
3. RELATIVE TO OTHER CONVERGENCE CONFIGURATIONS
4. SOLAR CELLS - SILICON OR GALIUM ARSENIDE (Si/GaAs)

PAYLOAD CONFIGURATION I4

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
MODIS	1121	1740	1213	2.366	1.95054	278	240	0.03	6500	±58 xtrk	Data Rate 11M sun
CERES	590	570	700	0.2354	0.3363	45	50	0.03	10	±84 cone, +Z	0
AMSU-A1	731	337	605	0.149	0.246347	50	90	0.1	2.1	+50,-90 xtrk	0
AMSU-A2	635	754	685	0.328	0.47879	50	37	0.1	1.1	+50,-90 xtrk	0
MHS-Sen & Electr	774	990	560	0.4291	0.76626	65	90	0.1	4.2	+50,-90 xtrk	
AIRS	1397	775	762	0.825	1.082675	165	265	0.2	1330	±55 xtrk	0
Totals				4.333	4.861	653	772		7847.4		

PAGES 69 THROUGH 74 ARE EXEMPT FROM RELEASE AND ARE REPLACED WITH THIS PAGE.

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P/L ACCOMMODATIONS SUMMARY - I4

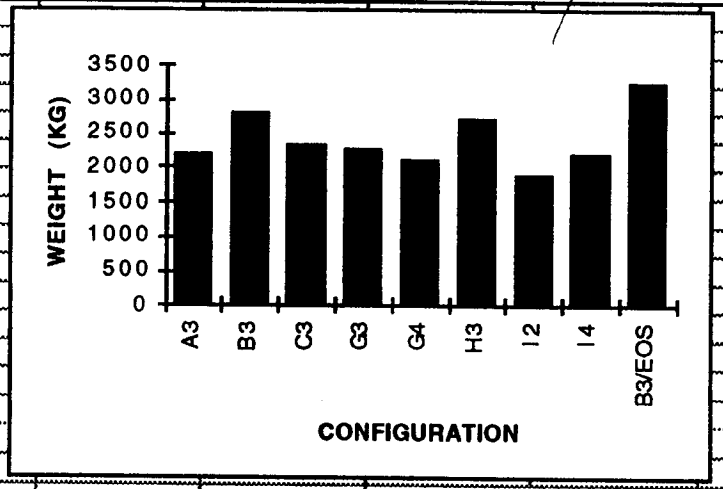
CATEGORY [1]	P/L DELTA [2]	S/C SIZING	CAPABILITY	RISK [3]
S/C WEIGHT	+87%	2193 KG	2700 KG	LOW
S/C POWER LOAD	+62%	1674 W	2.2/3.0 KW [4]	LOW
SOLAR ARRAY (BOL)	336 Sq Ft, Si	4.03 KW	5.4/7.3 KW [4]	LOW
DATA RATE	+175%	7.85 MBPS	C3/GRD	MEDIUM
FOV & SPACE	+228%	~ 175%	100%	HIGH

RISK ASSESSMENT - HIGH/MEDIUM. MODIS & AIRS LARGE VOLUME CONSIDERABLY LIMITS EQUIPMENT LOCATION. FOV - MAYBE SOME LIMITATIONS. DATA RATE INCREASE DUE TO MODIS & AIRS HAS A SIGNIFICANT IMPACT ON DATA HANDLING SIZING.

1. WITH CONTINGENCY, BUT NO GROWTH
2. PAYLOAD COMPARISON AGAINST DMSP B/L P/L'S
3. RELATIVE TO OTHER CONVERGENCE CONFIGURATIONS
4. SOLAR CELLS - SILICON OR GALIUM ARSENIDE (Si/GaAs)

S/C WEIGHT IMPACT

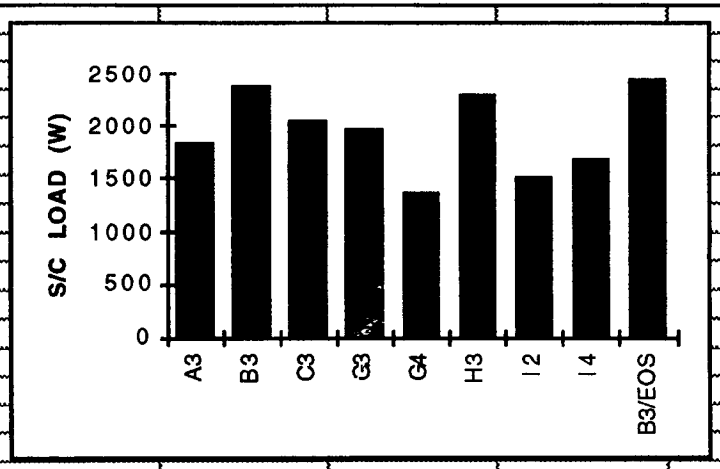
SUBSYSTEM	WEIGHT (KG)	WEIGHT (LBS)
STRUCTURES	500	1103
ELECTRICAL	480	1058
ATTITUDE DETERM & CTR	110	243
CMD, TLM, DH	150	331
PROPULSION	50	110
THERMAL	60	132
TOTAL DRY WEIGHT	1350	2977
PROPELLANT (DMSP B/L)	40	88
TOTAL S/C BUS	1390	3065



SENSOR COMPLEMENT	SENSOR TOTAL Kg	GROWTH(kg) B/L +25% CONV +0%	S/C DELTA Kg (38%) SSM+35Kg	TOTAL SATELLITE (KG)	TOTAL SATELLITE (LBS)	LAUNCH CAPABILITY 833KM, SUN SYNCH, 85% DELTA 7920 KG/LBS	LAUNCH CAPABILITY 833KM, SUN SYNCH, 85% ATLAS IIAS KG/LBS
DMSP BASELINE	350	88	0	1828	4030	2700/6000	
NOAA B/L	523	131	101	2144	4729	2700/6000	
CONFIGURATION							
A3	653	0	150	2193	4836	2700/6000	
B3	1086	0	315	2791	6153		4400/9700
C3	763	0	192	2345	5171	2700/6000	
G3	704	0	170	2264	4991	2700/6000	
G4	596	0	128	2114	4662	2700/6000	
H3	1027	0	292	2709	5974		4400/9700
I2	433	0	67	1890	4166	2700/6000	
I4	653	0	150	2193	4836	2700/6000	
B3/EOS	1086	0	760	3236	7135		4400/9700
(EOS BUS @ 2100 KG*)			* Adds 4th Battery				

S/C POWER IMPACT

SUBSYSTEM	POWER (W) DMSP	POWER (W) EOS
STRUCTURES		51
ELECTRICAL	56	120
ATTITUDE DETERM & CTR	213	198
CMD, TLM, DH	298	373
PROPULSION	3	33
THERMAL	195	73
SUB-TOTAL	765	
SURVIVABILITY	18	
TOTAL S/C BUS	783	848



SENSOR COMPLEMENT	SENSOR TOTAL W	GROWTH (W) B/L +25% CONV +0%	S/C DELTA W (15%) Comm +75	TOTAL SATELLITE LOAD W	Solar Array (BOL) W	SA WT-Diff KG (44w/kg)	BATTERY A-H Total DOD<35%	BATTERY Wt Diff (KG)
DMSP BASELINE	476	119	0	1378	3315	0	92	0
NOAA B/L	567	142	89	1580	3803	11.1	105	0
CONFIGURATION								
A3	910	0	140	1833	4412	24.9	122	0
B3	1385	0	211	2379	5728	54.8	159	0
C3	1095	0	168	2046	4925	36.6	136	0
G3	1026	0	158	1967	4733	32.2	131	0
G4	490	0	77	1350	3248	-1.5	90	0
H3	1316	0	201	2300	5537	50.5	153	0
I2	625	0	97	1505	3622	7.0	100	0
I4	772	0	119	1674	4029	16.2	112	0
B3/EOS	1385	0	276	2444	5885	58.4	163	50 **
(EOS BUS @ 945W)						** ADD 1 BATTERY (90 AH), IF REQUIRED		

DMSP/POES CONVERGENCE STUDY

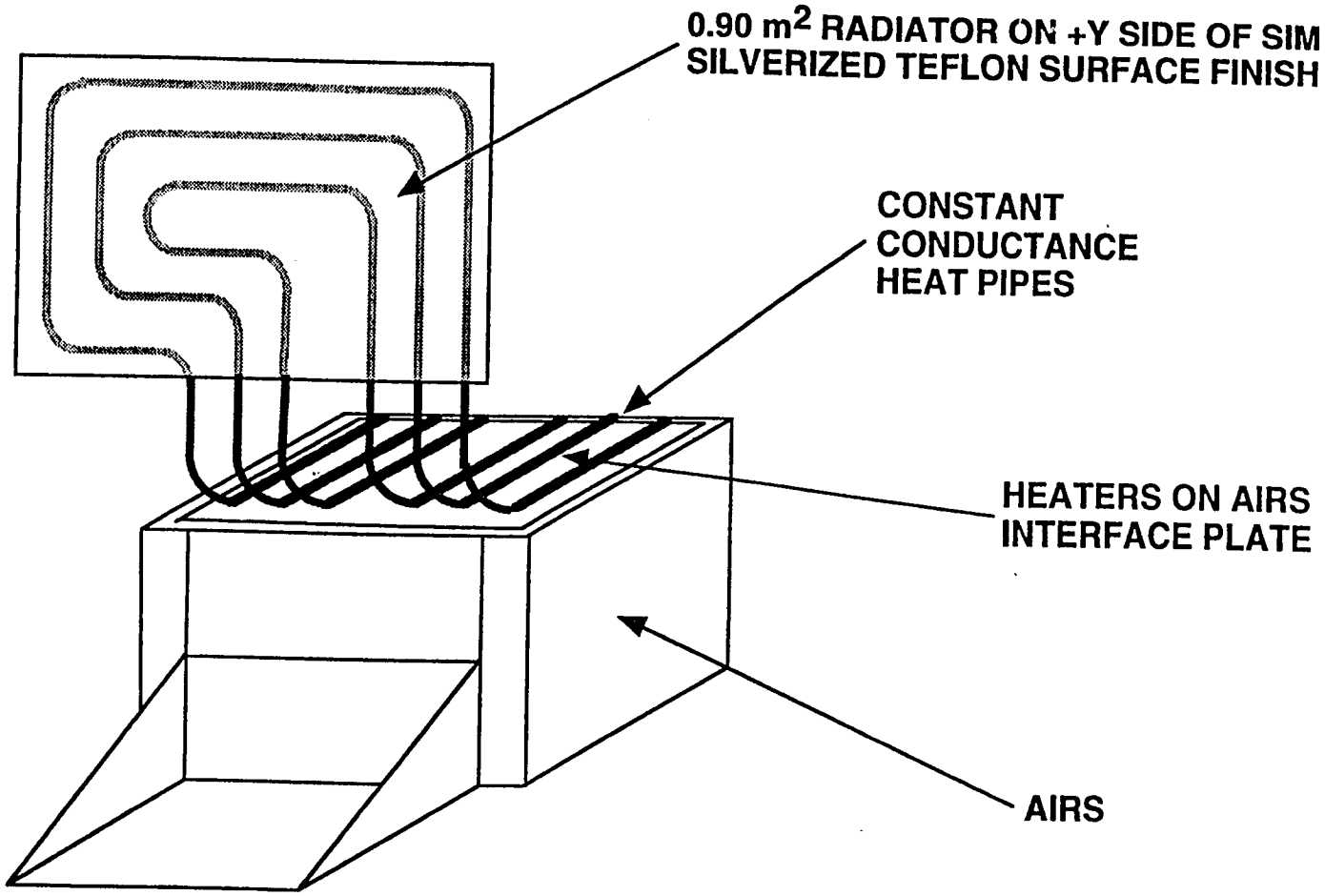
S/C PROPELLANT IMPACT

		DMSP B/L		NOAA B/L (OPQ PH A)		EOS B/L	
S/C MASS (KG)		1800		2400		3000	
ALTITUDE (KM)		833		824		705	
LIFE (YRS)		7		5		7	
ORBIT MAINT RQMT							
COVERAGE		100%					
ASC NODE				± 10 MIN			
REPEATING GRD TRK						± 1 KM	
ALTITUDE				±19 KM			
PROP BUDGET		DELTA V m/s	PROP WT kg N2H4	DELTA V m/s	PROP WT kg GN2	DELTA V m/s	PROP WT kg N2H4
INJECTION CORRECTION		10	11	4	19	20	37
SAFEMODE/ATTITUDE CTRL		23	26	tbd		10	19
ORBIT MAINT		5	6	6	29	60	110
TOTALS	m/s, kg	38	43	10	48	90	166
			BASED ON DELTA V = 40m/s AND HYDRAZINE				
CONVERGENCE CONFIG'S	DMSP B/L	B3	C3	G3	G4	H3	I4
S/C MASS (KG)	1828	2791	2345	2264	2114	2709	2193
DELTA V ESTIMATE (m/s)	38	40	40	40	40	40	40
PROPELLANT (KG)	43	69	58	56	52	67	54
PROP WT DELTA (KG)	0	26	15	13	9	24	11

PAYLOAD THERMAL REQUIREMENTS

INSTRUMENT	P/L POWER W	SENSOR RANGE DEG C	S/C COUPLING W *	BASE PLATE DEG C *	Elect Radiator DEG C	CYRO OP TEMP K	RADIATOR FOV RQMT
							COLD SPACE = +Y
							VELOCITY VECTOR=+X
							NADIR = +Z
AMSU-A1	90	0 TO 20	5 MAX	-5 TO + 30			
AMSU-A2	37	0 TO 20	5 MAX	-5 TO + 30			
MHS	90	0 TO 40	5 MAX	-5 TO + 30			
AIRS	265	15 TO 25	237	20 TO + 25	20 TO 25	155	+Y
ITS	75	TBD	5 MAX	-5 TO + 30			+Y
OMIS	230	0 TO 30 (TBR)	130	-5 TO + 30	0 TO 25	90	+Y (±90)
MISS	175	0 TO 40 (TBR)	10	-5 TO + 30			
MODIS	225	25 TO 35	5 MAX	-5 TO + 30	20	85	+Y (±85), +X
CERES	50	-15 TO 40	5 MAX	-5 TO + 30			
VIRSR	55	10 TO 30	5 MAX	-5 TO + 30		105	+Y
MIMR	200	-5 TO 40	5 MAX	-5 TO + 30			±Y, +X, +Z
	* PER NASA 2000 I/F SPEC						

AIRS THERMAL RADIATOR



SPACECRAFT CONFIGURATION SUMMARY

- **GOALS**
  - ACCOMMODATE PAYLOAD REQUIREMENTS
  - COMMON SPACECRAFT DESIGN FOR CONSTELLATION
  - IDENTIFY RISK AND COST
  - RECOGNIZE SYSTEM END-TO-END REQUIREMENTS
    - C3, OPERATIONS, & END-USERS

- **CONFIGURATION ANALYSIS**
  - MANY DIFFERENT PAYLOAD COMBINATIONS CAN BE ACCOMMODATED ON A COMMON SPACECRAFT DESIGN
    - MAXIMUM USE OF AVAILABLE WEIGHT, SPACE, AND POWER
    - WINGED BUS INHERENT HIGH CAPACITY AND FLEXIBLIITY
      - MAXIMIZES SPACING OF PAYLOADS AND ACCOMMODATING FOV'S
  - DELTA II, STANDARD SHROUD (10' x 312")
    - MEDIUM RISK FOR NUMEROUS MEDIUM SIZE PAYLOADS
    - HIGH RISK FOR LARGE 'EOS' TYPE PAYLOADS

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DMSP/POES CONVERGENCE STUDY

OMIS SENSOR SPECIAL STUDY TASK

PAUL CALLARY

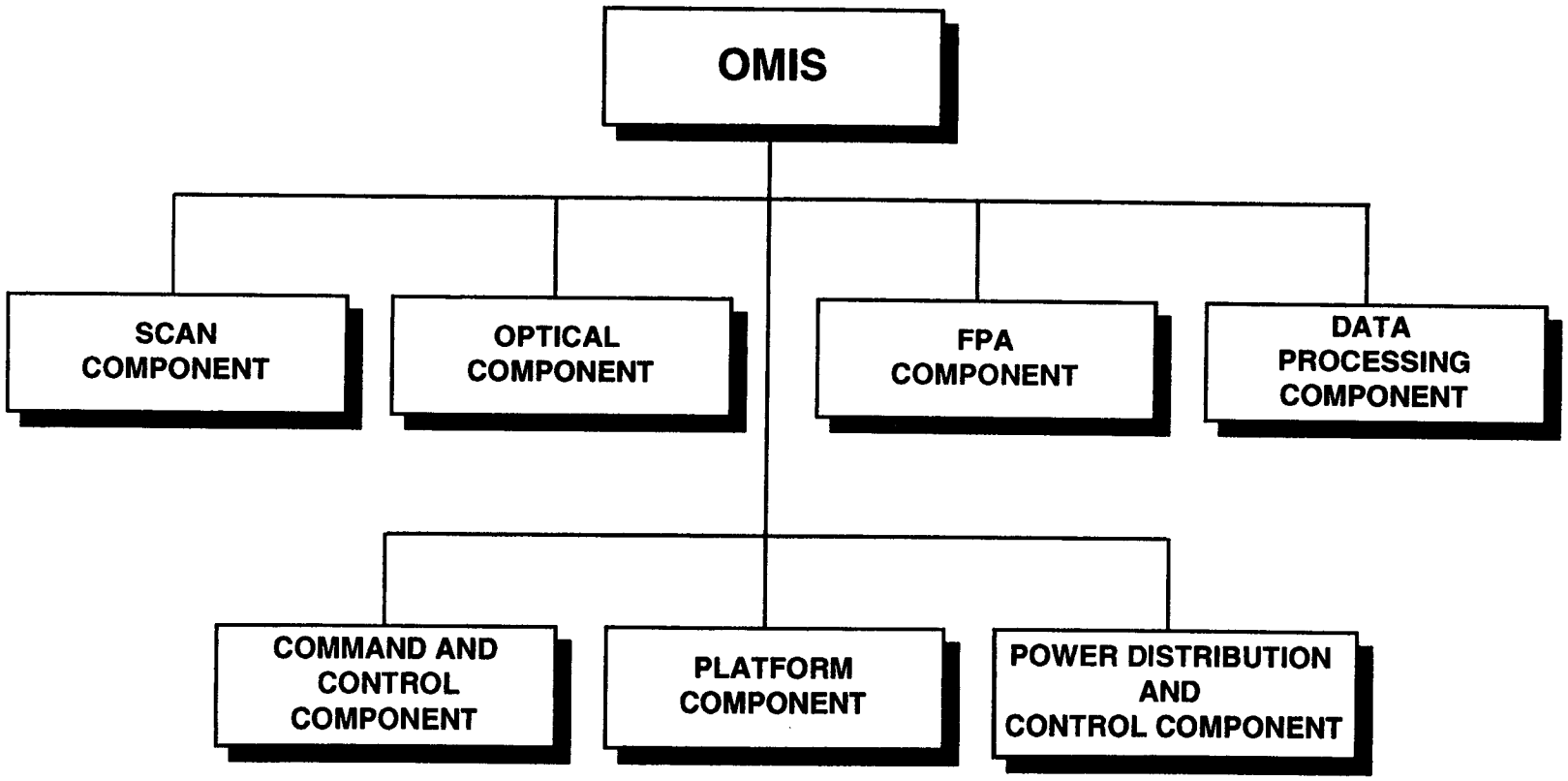
Task Statement

> "Perform peliminary analyses on the Common Omis calibration requirements. Determine risks and impacts to the Block 6 OMIS associated with satisfying all Common OMIS requirements."

PRESENTATION OVERVIEW OF STUDY TASKS RESULTS

- OMIS BASELINE DESCRIPTION
- COMMON OMIS CALIBRATION REQUIREMENTS COMPARED TO BASELINE OMIS REQUIRMENTS
- RISKS AND IMPACTS ASSOCIATED WITH COMMON OMIS REQUIREMENTS (INCLUDING CALIBRATION)

OPERATIONAL MULTI-CHANNEL IMAGER SUITE (OMIS)



OMIS SIZE/WEIGHT/POWER

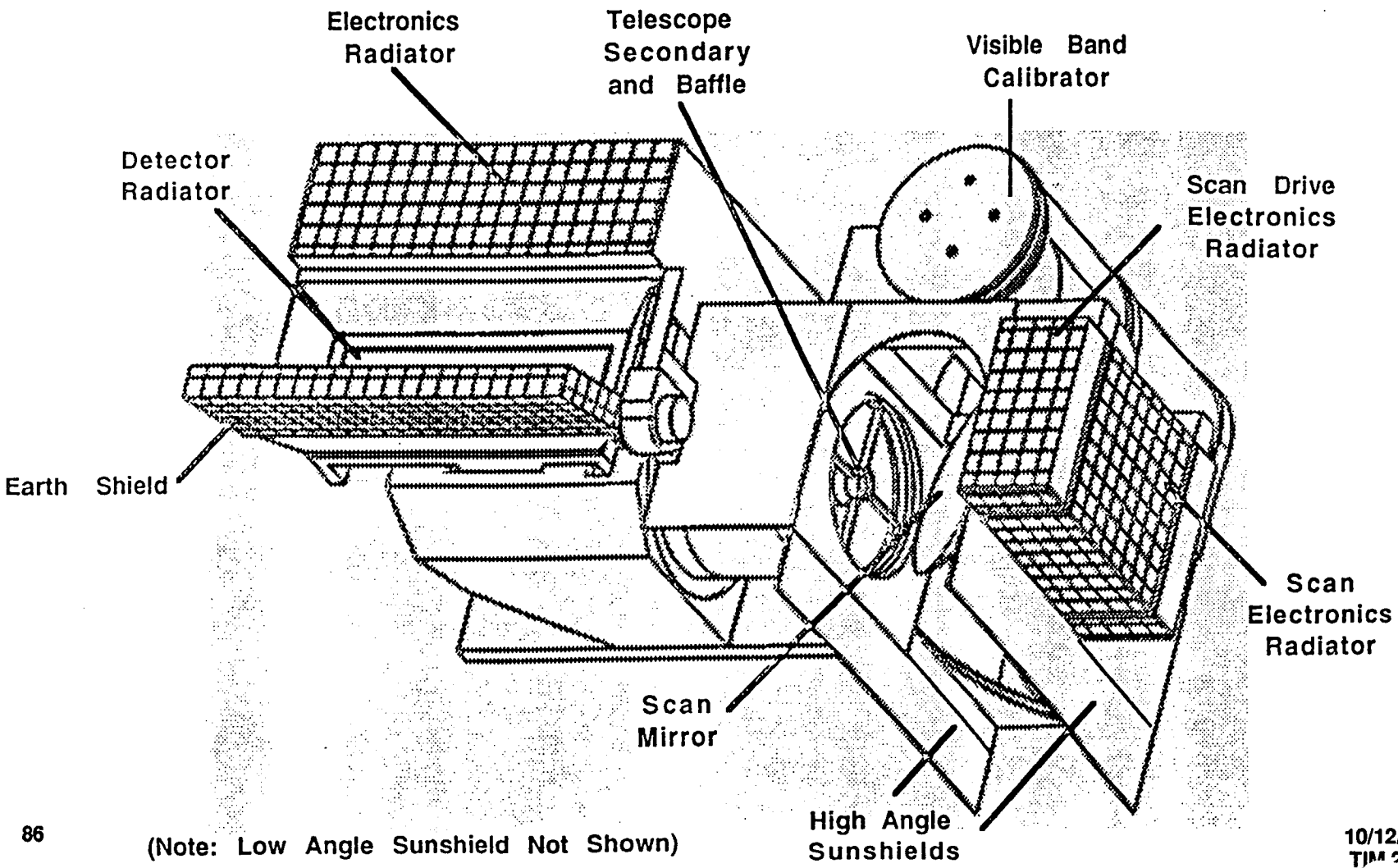
	W/MARGIN kg	W/MARGIN (lb)	W/O MARGIN kg	W/O MARGIN (lb)
SENSOR MODULE	95.1	(210)	65.7	(145)
ELECTRONICS MODULE	31.8	(70)	23.2	(51)
POWER MODULE	11.0	(24)	6.8	(15)
TOTAL	137.9	(304)	95.7	(211)

	LENGTH (in) (cm)	WIDTH (in)	HEIGHT (in)
SENSOR MODULE	132 52	63.5 25	61 ~~33~~ 24
ELECTRONICS MODULE	16	16	8
POWER MODULE	12	8	8

AVE. POWER = 194.7 W (W/O MARGIN)
= 216.9 W (W/ MARGIN)

PEAK POWER < 250 W

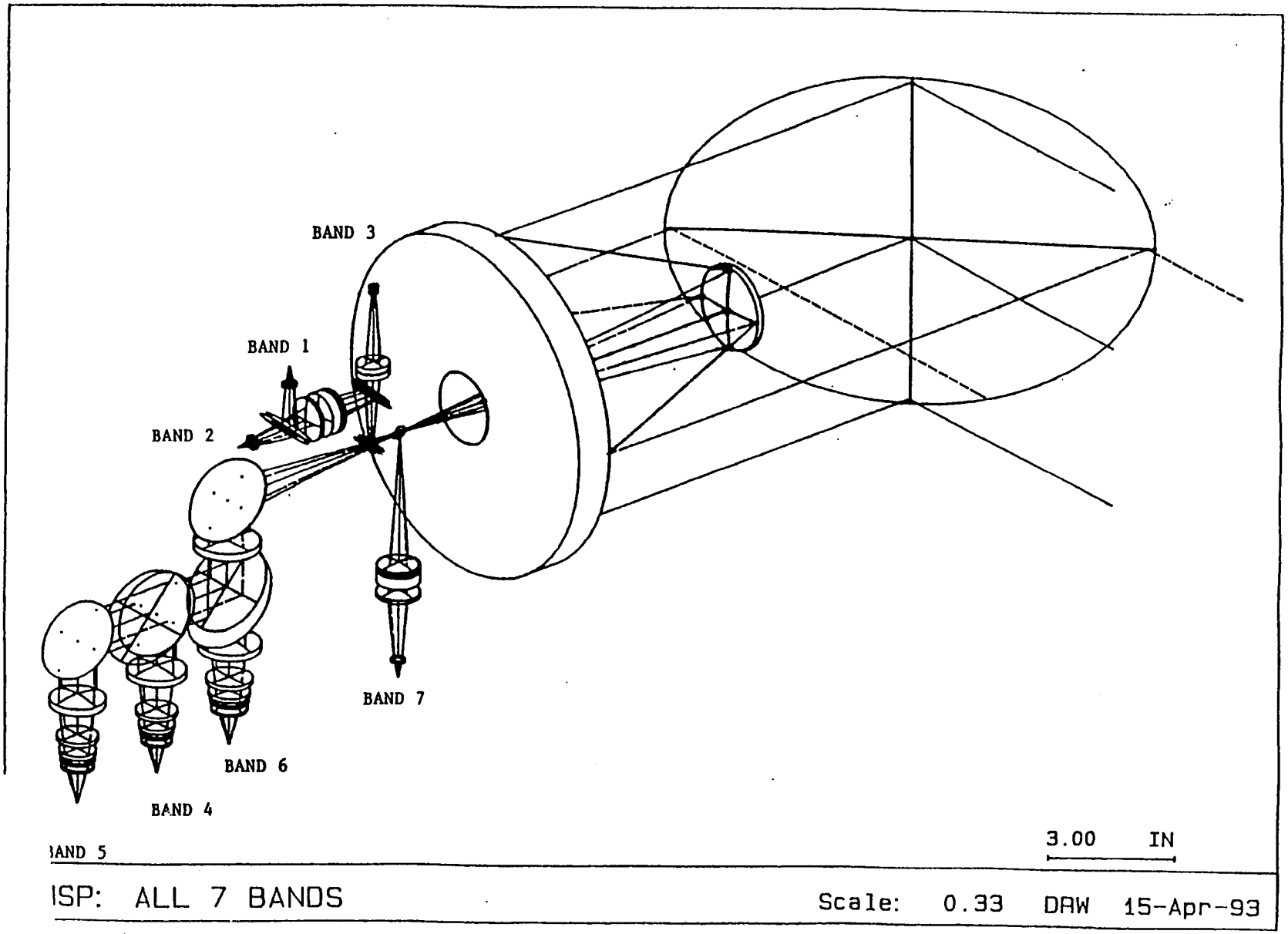
OMIS SENSOR MODULE



(Note: Low Angle Sunshield Not Shown)

DMSP/NOAA CONVERGENCE STUDY

OMIS BASELINE OPTICAL DESIGN FROM OPTIMA CODE



COMMON OMIS SENSOR CALIBRATION REQUIREMENTS

PRESENTATION OVERVIEW

- REVIEW CURRENT DMSP BASELINE OMIS CALIBRATION REQUIREMENTS AND CAPABILITY
- COMPARISON OF BASELINE TO "COMMON OMIS CALIBRATION" REQUIREMENTS
- RISK ASSESSEMENT WITH FOLLOWING RISK SECTION

QUICK SUMMARY

- COMMON OMIS CALIBRATION REQUIREMENTS ARE:
  - LESS STRINGENT THAN THE BASELINE OMIS IN THE IR BANDS
  - MORE STRINGENT THAN THE BASELINE IN THE VISIBLE BANDS

DMSP/POES CONVERGENCE STUDY

BASELINE DMSP CALIBRATION REQUIREMENTS FOR OMIS (1 0F 8)

RADIOMETRIC REQUIRMENTS AND OMIS PERFORMANCE

BAND	ABSOLUTE ACCURACY REQUIREMENT (1-sigma)	PRECISION (1-sigma) NADIR	PRECISION (1-sigma) END-OF-SCAN	ABS. ACCURACY (1-sigma) NADIR	ABS. ACCURACY (1-sigma) END-OF-SCAN	MARGIN END-OF-SCAN
1	7%	67	47	2.2%*	2.7%*	2.6:1
2	7%	75	53	2.1%*	2.5%*	2.8:1
3	10%	20	14	5.3%*	7.3%*	1.4:1
7	17%	13.3	9.4	8.2%***	11.1%***	1.5:1
4	0.85K @ 260K	0.35	0.50	0.42**	0.55**	1.5:1
	1.0 K @ 240K	0.99	1.4	1.20**	1.55**	0.6:1 ^^
5	0.3 K @ 270K	0.06	0.09	0.10**	0.12**	2.5:1
	0.9 K @ 180K	0.33	0.46	0.55**	0.63**	1.4:1
6	0.3 K @ 270 K	0.11	0.15	0.13**	0.17**	1.7:1
	0.9 K @ 180K	0.45	0.64	0.56**	0.72**	1.3:1

* CALIBRATION ERROR (1 sigma) = 1.7%

** CALIBRATION ERROR (3 sigma) =0.2K @ 288K

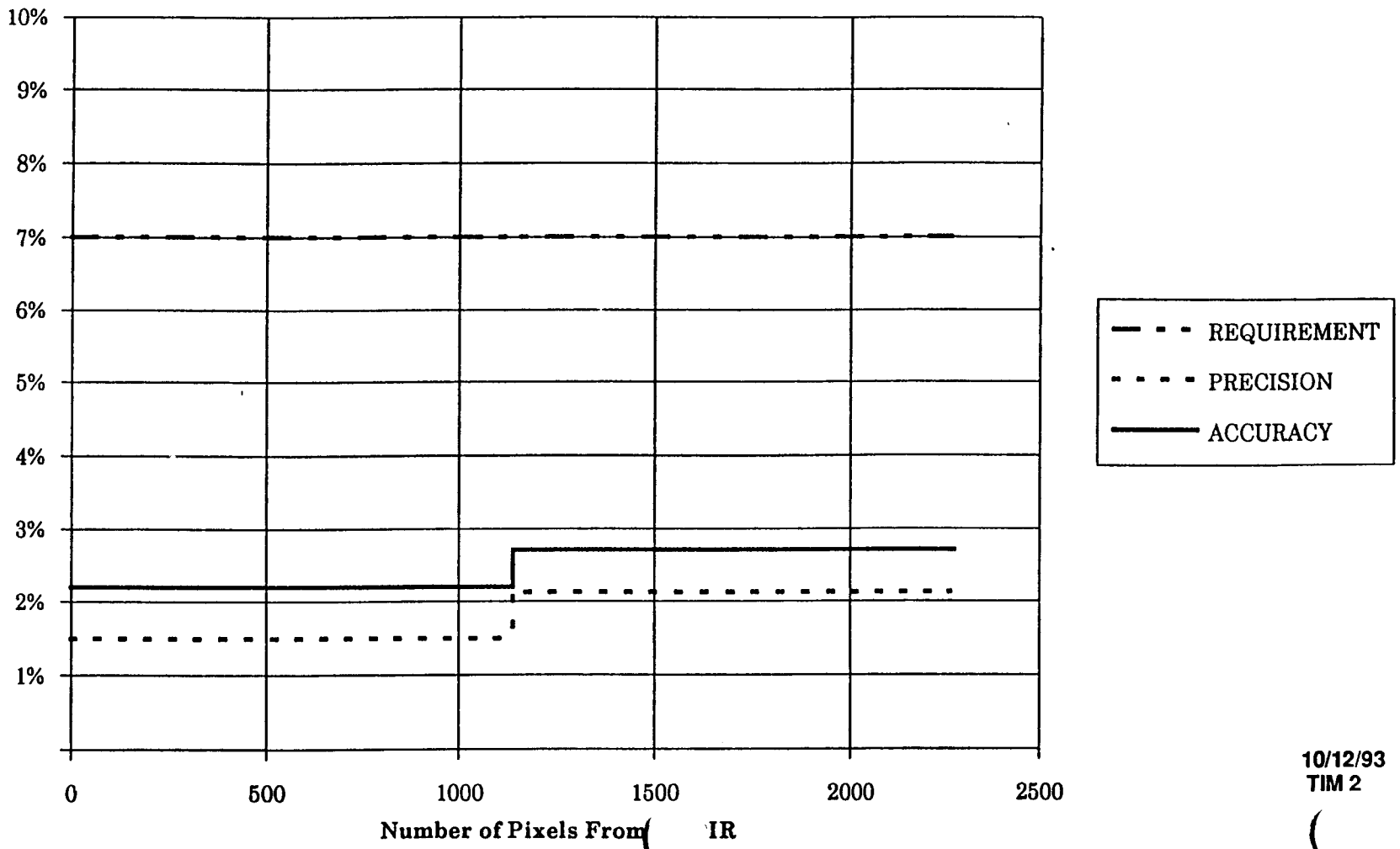
*** CALIBRATION ERROR (1 sigma) = 3.3%

^^ REQUIRMENT AT 240K UNDER DISCUSIION WITH SPO ...CHANGE TO 255-260K EXPECTED

BASELINE DMSP CALIBRATION REQUIREMENTS FOR OMIS (2 0F 8)

BAND 1 (0.5-0.7 μm)

OMIS BAND 1 PERFORMANCE @ 7E-5 W/CM^2 SR

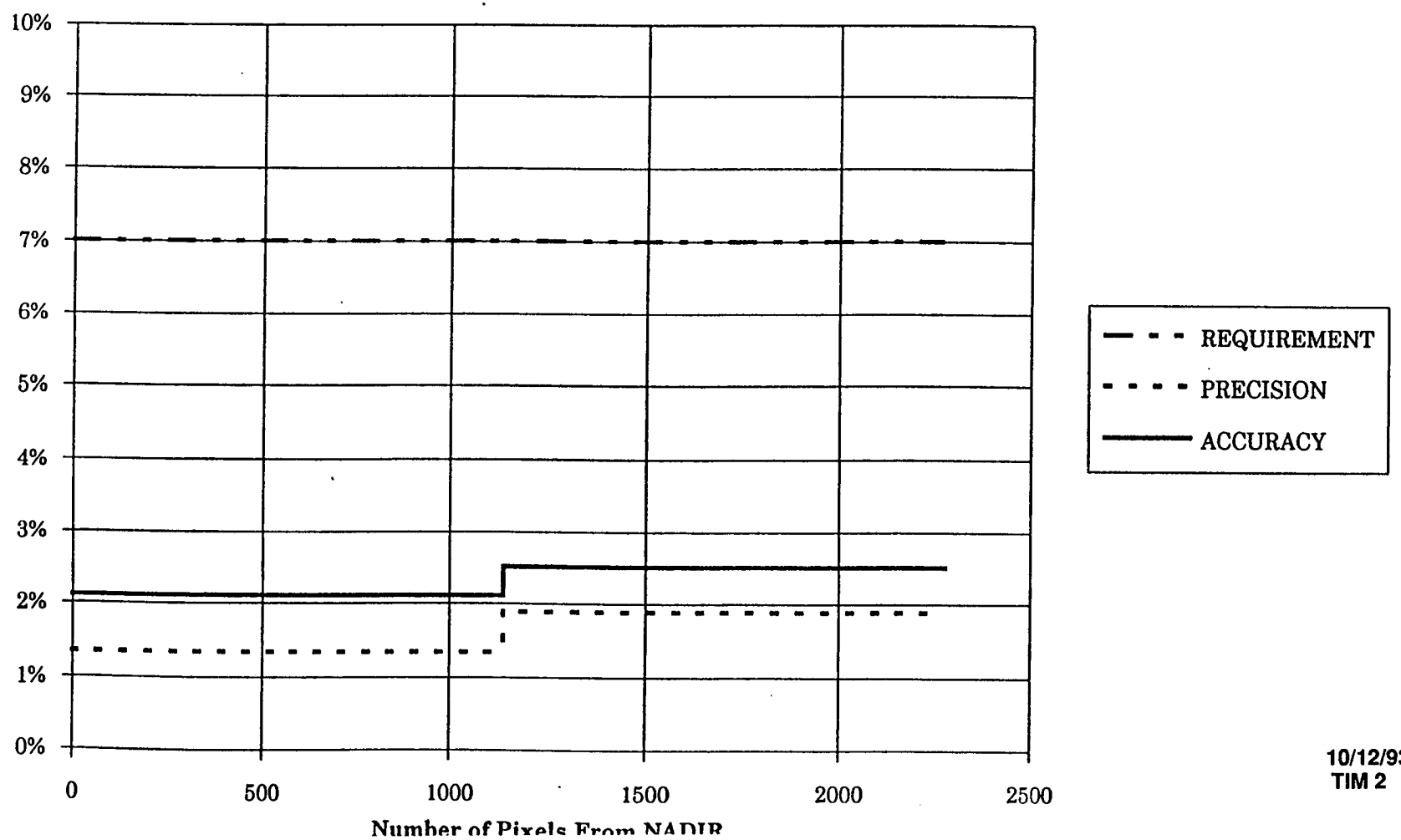


DMSP/NOAA CONVERGENCE STUDY

BASELINE DMSP CALIBRATION REQUIREMENTS FOR OMIS (3 0F 8)

BAND 2 (0.7 -1.0 μm)

OMIS BAND 2 PERFORMANCE @ 7E-5 W/CM^2 SR



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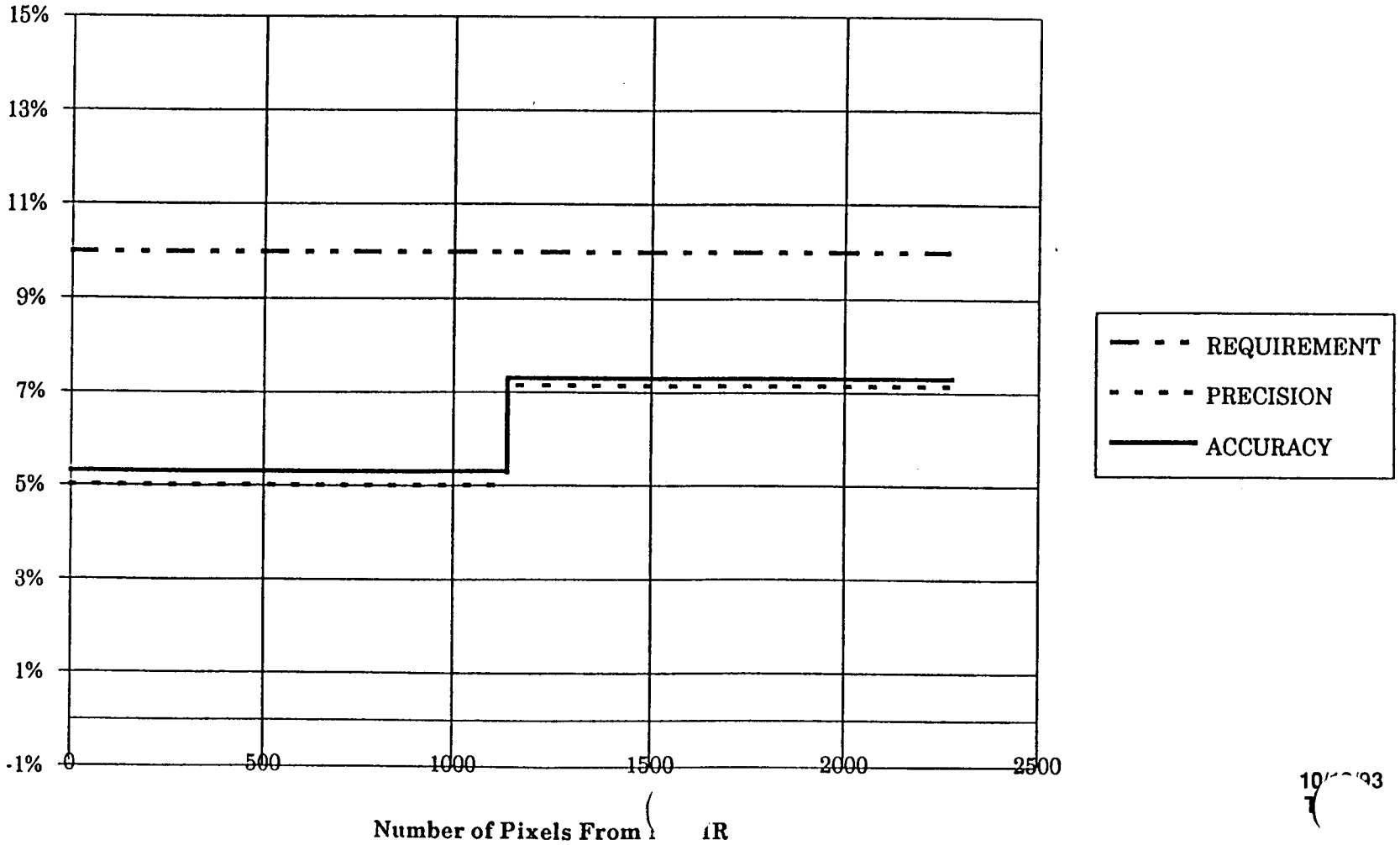
TIM 2

DMSP/NOAA CONVERGENCE STUDY

BASELINE DMSP CALIBRATION REQUIREMENTS FOR OMIS (4 0F 8)

BAND 3 (1.5 -1.7 μm)

OMIS BAND 3 PERFORMANCE @ 7E-5 W/CM^2 SR



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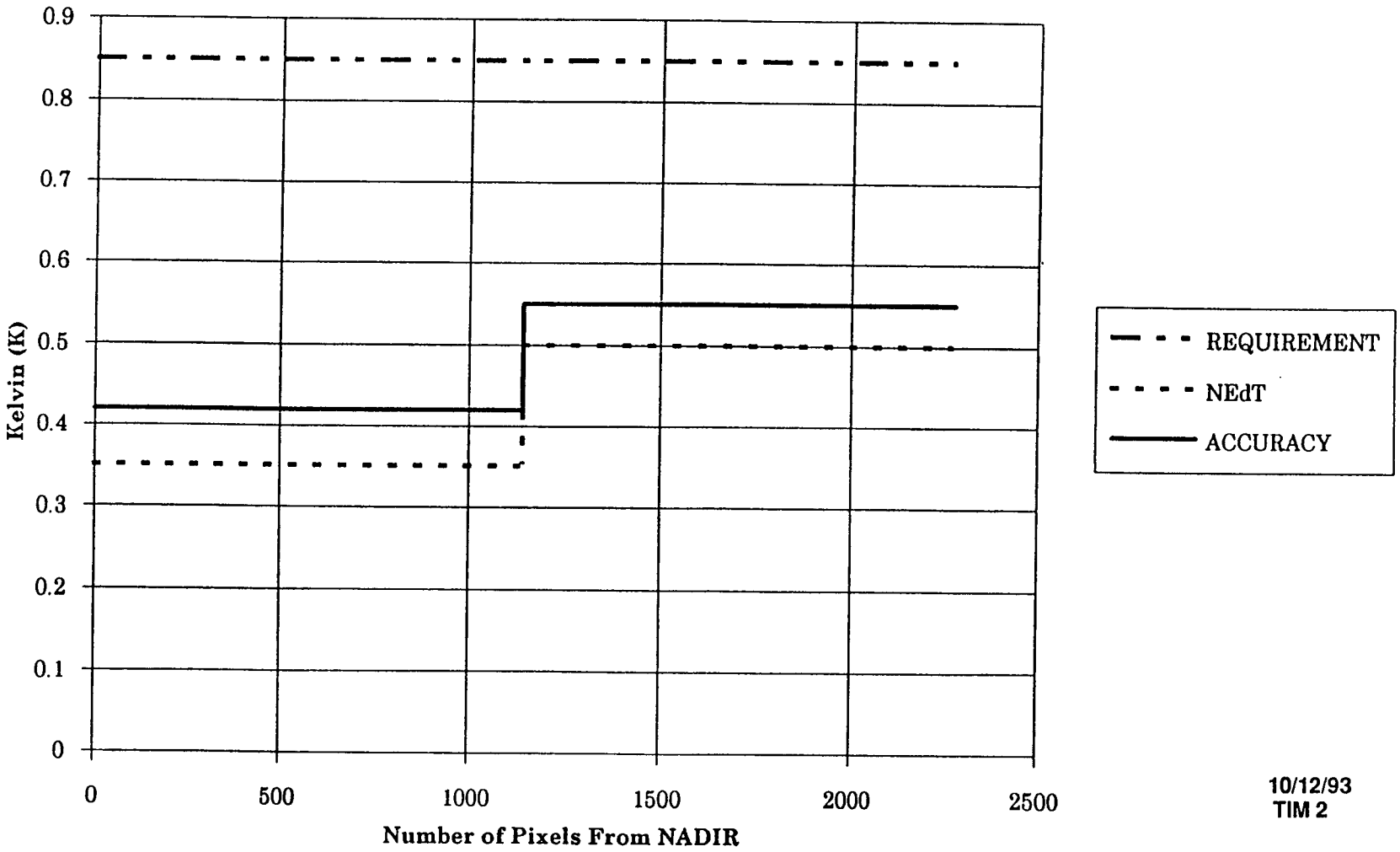
DMSP/NOAA CONVERGENCE STUDY

BASELINE DMSP CALIBRATION REQUIREMENTS FOR OMIS (5 0F 8)

BAND 4 (3.55 - 4.0 μm)

OMIS BAND 4 PERFORMANCE @ 260K



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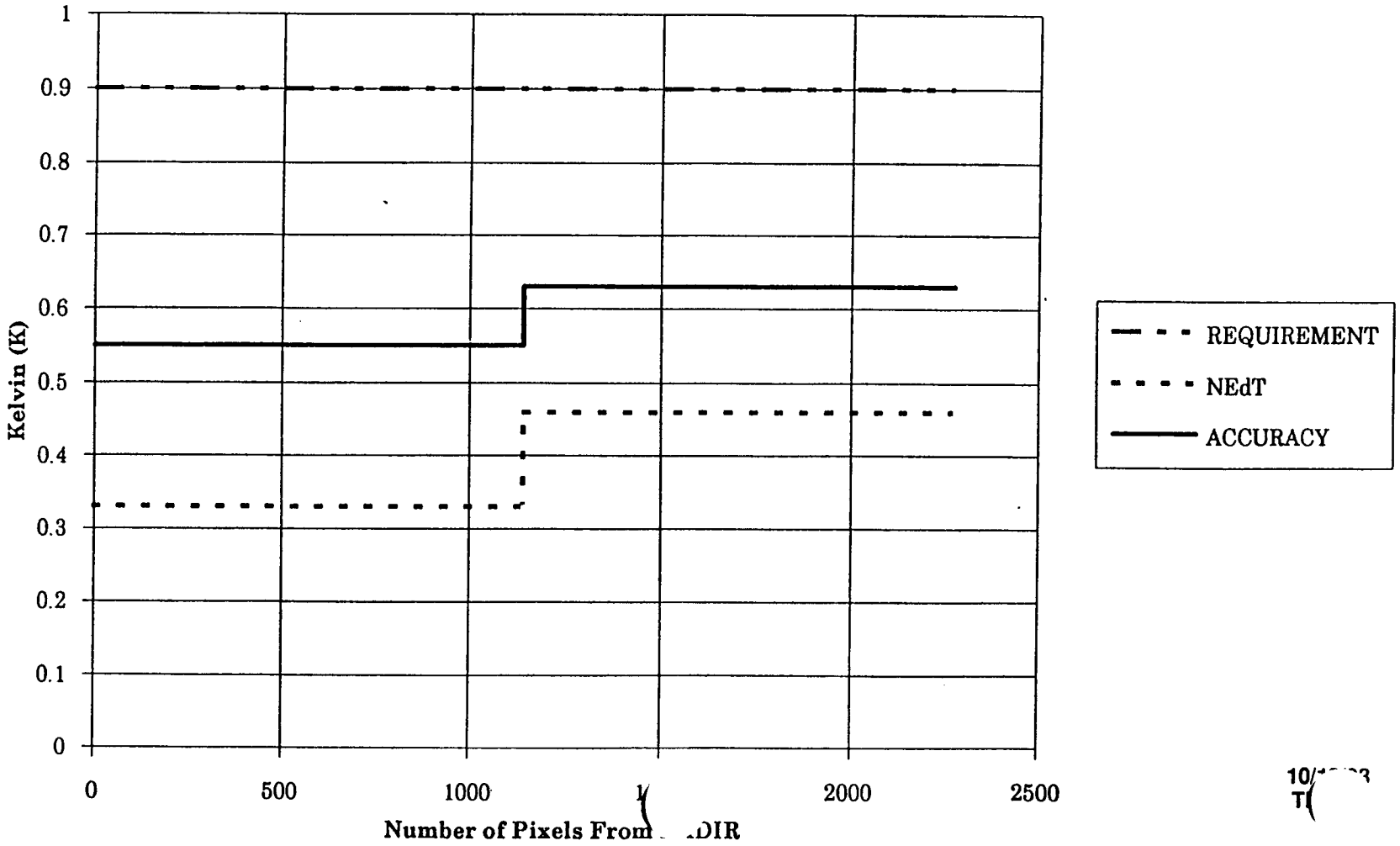
TIM 2

DMSP/NOAA CONVERGENCE STUDY

BASELINE DMSP CALIBRATION REQUIREMENTS FOR OMIS (6 0F 8)

BAND 5 (10.3 - 11.3 μm)

OMIS BAND 5 PERFORMANCE @ 180K

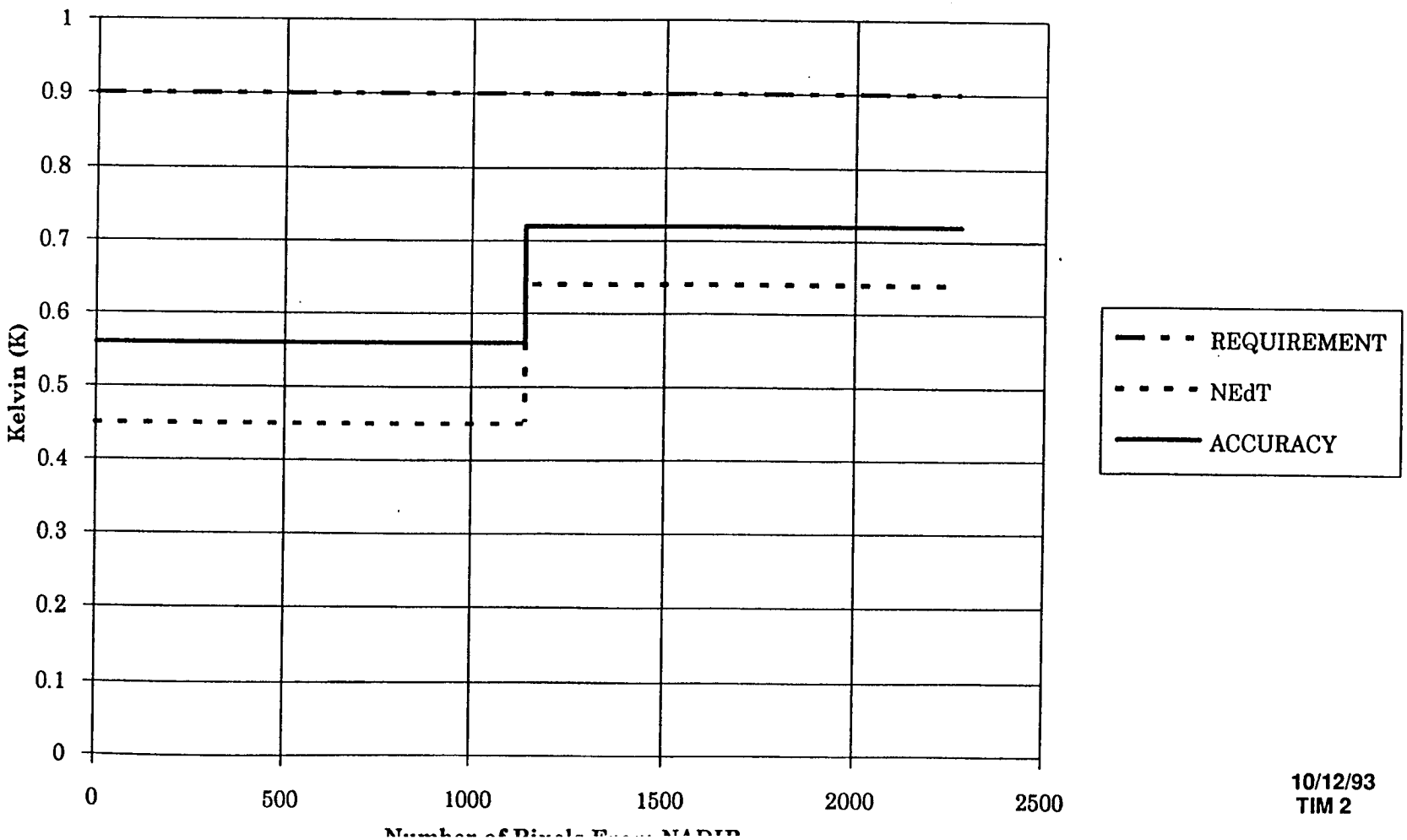


DMSP/NOAA CONVERGENCE STUDY

BASELINE DMSP CALIBRATION REQUIREMENTS FOR OMIS (7 0F 8)

BAND 6 (11.5 - 12.5 μm)

OMIS BAND 6 PERFORMANCE @ 180K



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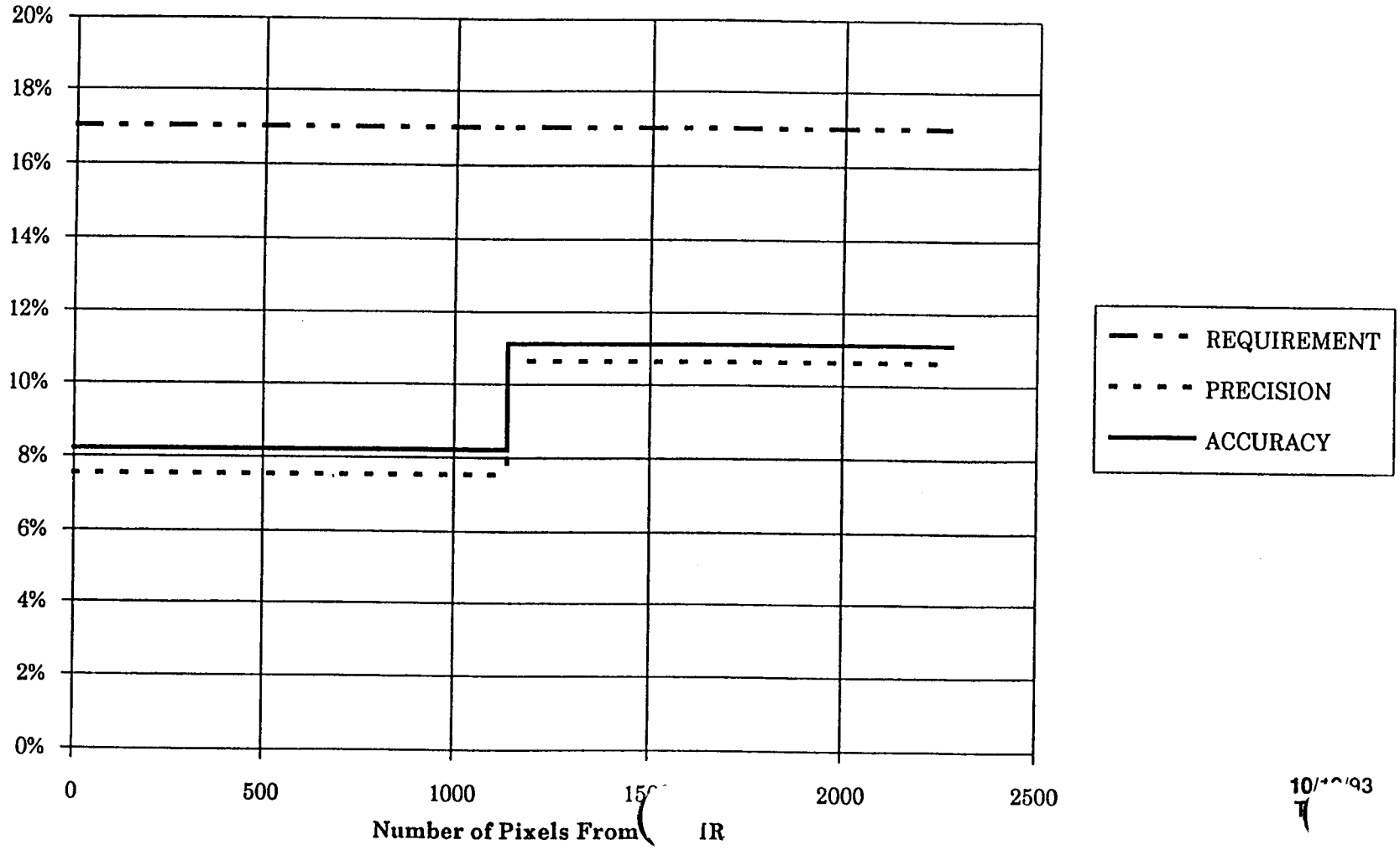
TIM 2

DMSP/NOAA CONVERGENCE STUDY

BASELINE DMSP CALIBRATION REQUIREMENTS FOR OMIS (8 0F 8)

BAND 7 (0.4 - 1.0 μm) - LOWLIGHT LEVEL BAND

OMIS BAND 7 PERFORMANCE @ 1E-9 W/CM^2 SR



DMSP/POES CONVERGENCE STUDY

COMPARISON OF BASELINE TO COMMON OMIS CALIBRATION REQMNTS

	BASELINE OMIS	EQUIVALENT COMMON OMIS REQUIREMENTS		
BAND	ABSOLUTE ACCURACY REQUIREMENT (1-sigma)	PRECISION (1-sigma) END-OF-SCAN	CALIBRATION (1-sigma) END-OF-SCAN	ABS. ACCURACY (1-sigma) END-OF-SCAN
1	7%	SNR =10	3%	10.4% *
2	7%	SNR =10	3%	10.4% **
3	10%	SNR =10.5	3%	10.9%
7	17%	SNR =6	3.3%	17 % ***
4	0.85K @ 260K 1.0 K @ 240K	NEΔT =0.27K	1K @ 273 K	1K @ 273 K
5	0.3 K @ 270K 0.9 K @ 180K	NEΔT =0.09 K	1K @ 273 K	1K @ 273 K
6	0.3 K @ 270 K 0.9 K @ 180K	NEΔT =0.15K	1K @ 273 K	1K @273 K

* WITH A FACTOR OF 10X SIGNAL REDUCTION
** WITH A FACTOR OF 15.9X SIGNAL REDUCTION
*** WITH A FACTOR OF 4X SIGNAL INCREASE

ASSESSMENT OF RISK FOR MEETING COMMON OMIS REQUIREMENTS (1 OF 6)

OVERVIEW

- <u>COMMON REQUIREMENTS ASSESSED</u>
  - SNR OR NEΔT
    - » MUCH MORE NARROW SPECTRAL BANDPASS FOR BANDS 1 AND 2
  - CALIBRATION
  - SPATIAL RESOLUTION
    - » BASELINE AT 0.65 km $\pm$ 25%
    - » INITIAL LOOK AT 0.55 km WITH 2X FOOTPRINT GROWTH ALLOWED
  - ADDITION OF BAND 8
  - DATA RATE i.e. 12 BITS PER CHANNEL

ASSESSMENT OF RISK FOR MEETING COMMON OMIS REQUIREMENTS (2 OF 6)

SNR OR NEΔT

KEY CHANGE

- SIGNIFICANT REDUCTION IN SIGNAL DUE TO NARROWER VISIBLE SPECTRAL BANDPASSES FOR CONVERGED SENSOR
  - OMIS BAND 1 SIGNAL REDUCED BY A FACTOR OF 10X
    - » BANDPASS CHANGED FROM 0.5 - 0.7 To 0.605 - 0.625 μm
  - OMIS BAND 2 SIGNAL REDUCED BY A FACTOR OF 15.9X
    - » BANDPASS CHANGED FROM 0.7 - 1.0 To 0.86 - 0.88 μm
- COMBINATION OF APERTURE SIZE INCREASE AND FPA COMPLEXITY INCREASE IS REQUIRED WITH NARROW SPECTRAL BANDS
  - INCREASE APERTURE TO IMPROVE SIGNAL
  - MORE COMPLEX FPA TO REDUCE NOISE

RISK ASSESSMENT

- BANDS 1 AND 2 HAVE HAD A SIGNIFICANT CHANGE
  - NORMALLY RISK WOULD BE HIGH, HOWEVER, BASELINE HAD EXCESS SNR MARGIN
  - WITH INCREASED APERTURE RISK IS LOW
- THERMAL BANDS HAVE BEEN PROVIDED RELIEF
- BAND 7 PROVIDED A FACTOR OF 4 RELIEF

ASSESSMENT OF RISK FOR MEETING COMMON OMIS REQUIREMENTS (3 OF 6)

CALIBRATION

KEY CHANGE

- VISIBLE CALIBRATION REQUIREMENTS
  - NUMERIC RELIEF, BUT SNR REDUCTION REDUCES EXISTING MARGIN
- THERMAL BANDS
  - COMMON OMIS REQUIREMENTS ARE EASIER TO MEET THAN THE BASELINE OMIS REQUIREMENTS
- LOW LIGHT LEVEL (BAND 7)
  - NUMERIC REQUIREMENT REMAINS THE SAME, HIGHER SIGNAL LEVEL IMPROVES MARGIN

RISK ASSESSMENT

- REQUIREMENTS ARE HARDER IN THE VISIBLE BANDS
  - *ASSESSED AS MODERATE RISK* UNTIL CALIBRATOR DESIGN IS MORE MATURE
- IR BAND REQUIREMENTS HAVE BEEN RELAXED
  - *ASSESSED AS LOW RISK*

ASSESSMENT OF RISK FOR MEETING COMMON OMIS REQUIREMENTS (4 OF 6)

SPATIAL RESOLUTION

- **NO CHANGES HAVE BEEN MADE TO THE BASELINE**
  - 0.65 km ± 25% OVER ENTIRE SCAN

ASSESSMENT OF RISK FOR MEETING COMMON OMIS REQUIREMENTS (5 OF 6)

ADDITION OF BAND 8

KEY CHANGE

- ADDITION OF 8.4-8.7 μm Band

RISK ASSESSMENT

- NO IMPACT
  - OMIS BASELINE HAS ALWAYS MADE PROVISION FOR THE ADDITION OF AN 8TH BAND

ASSESSMENT OF RISK FOR MEETING COMMON OMIS REQUIREMENTS (6 OF 6)

DATA RATE

KEY CHANGE

- **CHANGES TO QUANTIZATION LEVELS**
  - 4 VISIBLE BANDS FROM 8 bits/pixel TO 12 bits/pixel
  - 3 IR BANDS FROM 10 bits/pixel TO 12 bits/pixel
  - ADDITION OF 8.55μm BAND AT 12 bits/pixel
  - DESIGN WILL NEED 13-14 BIT A/D CONVERTER
- **OMIS DATA RATE CHANGED FROM 2.8 Mbps to 4.5 Mbps**
  - NOT A DRIVER ON OMIS RISK
- **IMPACT IS REALLY TO OBP AND DATA LINKS**
  - DATA COMPRESSION ISSUE (DISCUSSED IN ANOTHER SECTION OF THIS BRIEFING)

RISK ASSESSMENT

- NO RISK INCREASE TO OMIS PROCESSOR
- A/D CONVERTER AVAILABILITY IS A CONCERN BUT MANY PROGRAMS ARE PURSUING THIS TECHNOLOGY - RISK IS LOW TO MODERATE

SYSTEM AND C^3 ANALYSIS

TOM PARSONS

DMSP/POES CONVERGENCE STUDY

- DEFINED ON-BOARD SENSOR DATA DRIVERS
- EVALUATED C^3 AND DATA ROUTING ALTERNATIVES
  - DRR
  - GEO X-LINKS
  - BACKHAUL
  - SOC
- ANALYZED RISKS AND IDENTIFIED MITIGATION APPROACHES
  - DATA COMPRESSION
  - DOWNLINKS
  - RFI

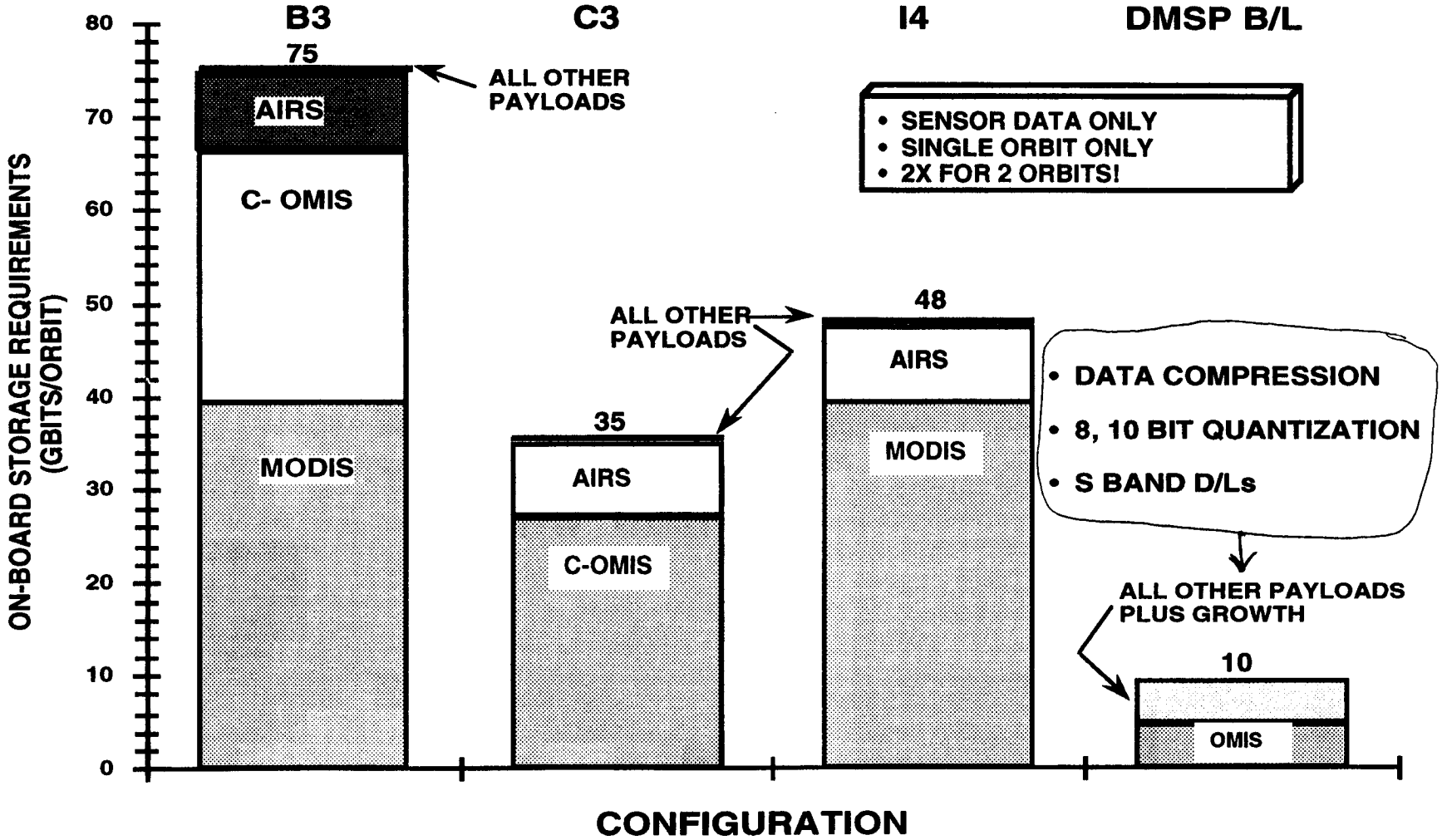
C2 & DRR IMPACT SUMMARY

- THE CONVERGED SYSTEM'S HIGH DATA RATES DRIVE
  - SYSTEM DESIGN
  - LIFE CYCLE COST
- DATA COMPRESSION IS AN EMERGING TECHNOLOGY WHICH CAN EASE THE SYSTEM IMPACTS OF HIGH DATA RATES
- AUTOMATION OF SATELLITE COMMAND AND CONTROL FUNCTIONS
  - REDUCES O&M COSTS
  - EASES TRANSITION

RAPID DEVELOPMENT OF U.S. COMMUNICATIONS INFRASTRUCTURE WILL ENHANCE USER CONNECTIVITY

DMSP/POES CONVERGENCE STUDY

CONVERGED / DMSP ON-BOARD STORAGE COMPARISON



10/19/93
TIM 2

TIM #2 SPECIAL STUDY TASKS

- EXAMINE ALTERNATIVE C2 AND DATA ROUTING AND RETRIEVAL OPTIONS PRESENTED IN ATTACHMENT 4 TABLE 4-1 AND 4-2.
- EXAMINE OTHER OPTIONS NOT DEFINED IN ATTACHMENT 4 IF POTENTIALLY BENEFICIAL IN TERMS OF COSTS AND OPERATIONS
- DETERMINE TOP LEVEL SPACE SEGMENT AND C3 SEGMENT IMPACTS FOR EACH C2 AND DRR OPTION
- DETERMINE IF DATA CAN BE DOWNLINKED IN S-BAND FOR ANY OF THE DATA COMPRESSION ALTERNATIVES LISTED IN TABLE 4-3

CONVERGED C3 ELEMENT FUNCTIONS

COMMAND, CONTROL, & COMMUNICATION SEGMENT C3

REMOTE TRACKING SYSTEM (RTS / CDA)

- Tracking
- Range / Timing
- Acquisition
- Ephemeris Generation

DATA ROUTING & RETRIEVAL (DRR)

- Mission Data Routing
  - Stored
  - Realtime
- Equip. Status & Telemetry
- Commands & Stored Program Upload
- SDC & SAR Data

SATELLITE OPERATIONS CENTER (SOC)

- Mission Control
- Mission Planning
- Command Generation
- Computer Memory Upload Generation
- Telemetry Analysis
- Launch/Early Orbit
- Command & Control
- Anomaly Resolution
- Store & Forward
- Launch Interface

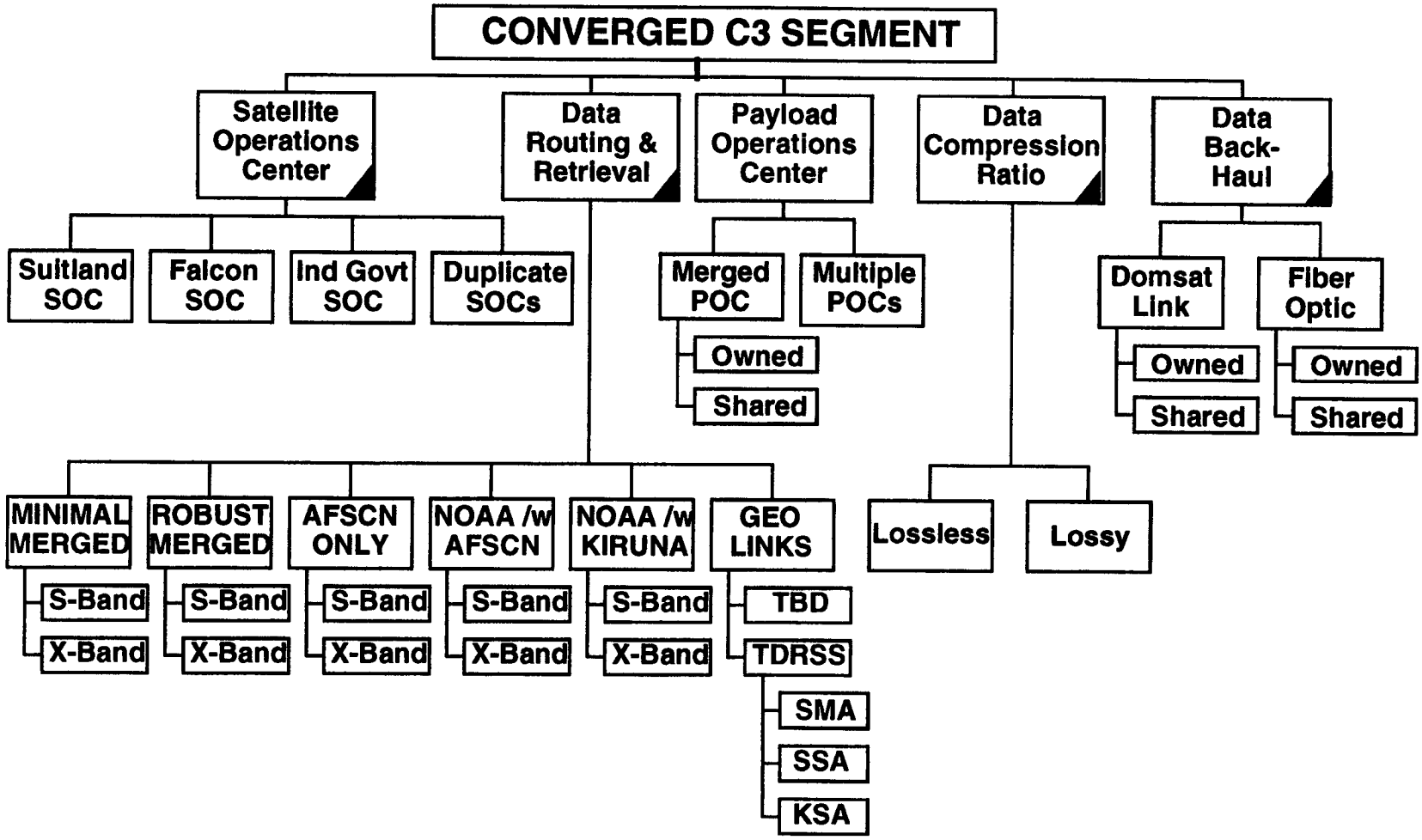
PAYLOAD OPERATIONS CENTER (POC)

- Payload Control
- Sensor Planning
- User Request Relay
- Sensor Command Generation
- Sensor Data Analysis
- Anomaly Resolution

FLIGHT VEHICLE SIMULATION FACILITY (FVSF)

- S/C Enviro. Simulation
- Uplink/Downlink I/F Validation
- Flight Load Package Validation

CONVERGED C3 TRADE TREE

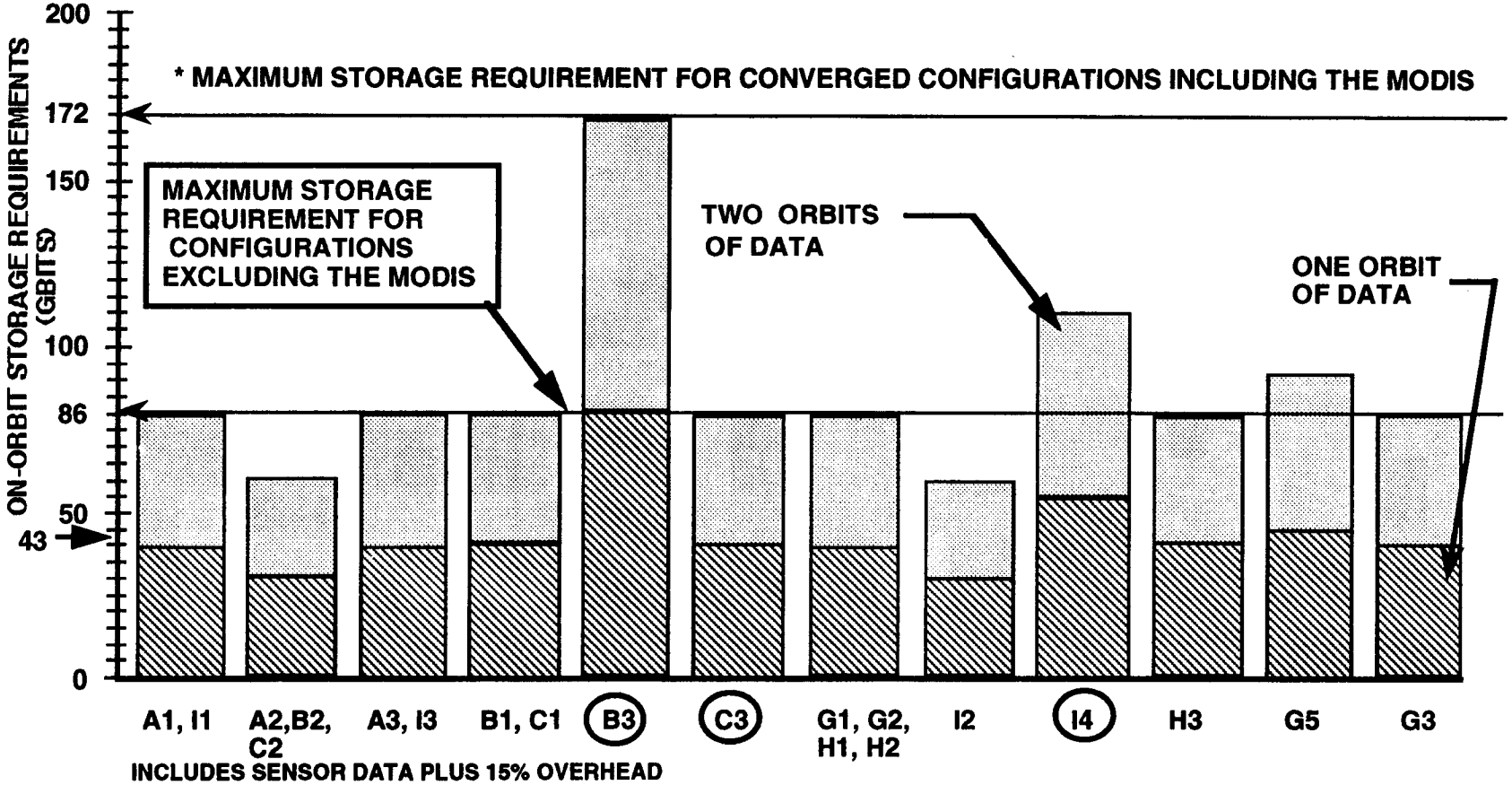


REQUIREMENTS/CONSTRAINTS

	PARAMETER	REQUIREMENT	SOURCE
√	SMD D/L FREQUENCY	7.455 GHZ (X-BAND)	STATED IN STUDY
√	DATA VOLUME	43 - 172 GBITS/ORBIT	DERIVED
√	DATA TIMELINESS	131 MIN. (AVERAGE)	DMSP BLOCK 6
√	SMD DATA RATE	75-180 MBPS (BASELINE)	DERIVED
	SMD SECURITY	ENCRYPTION REQUIRED	STATED IN STUDY
	REAL-TIME D/Ls		
	• HRPT	3.5 MBPS@ 1.7 GHZ	• STATED IN STUDY
	• LRPT	72 KBPS@ 137 MHZ	• STATED IN STUDY
	• DMSP HI-RES	1.0 MBPS@ 2.2 GHZ	• DMSP R/R
	• DMSP LO-RES	100 KBPS@ 401 MHZ	• DMSP R/R

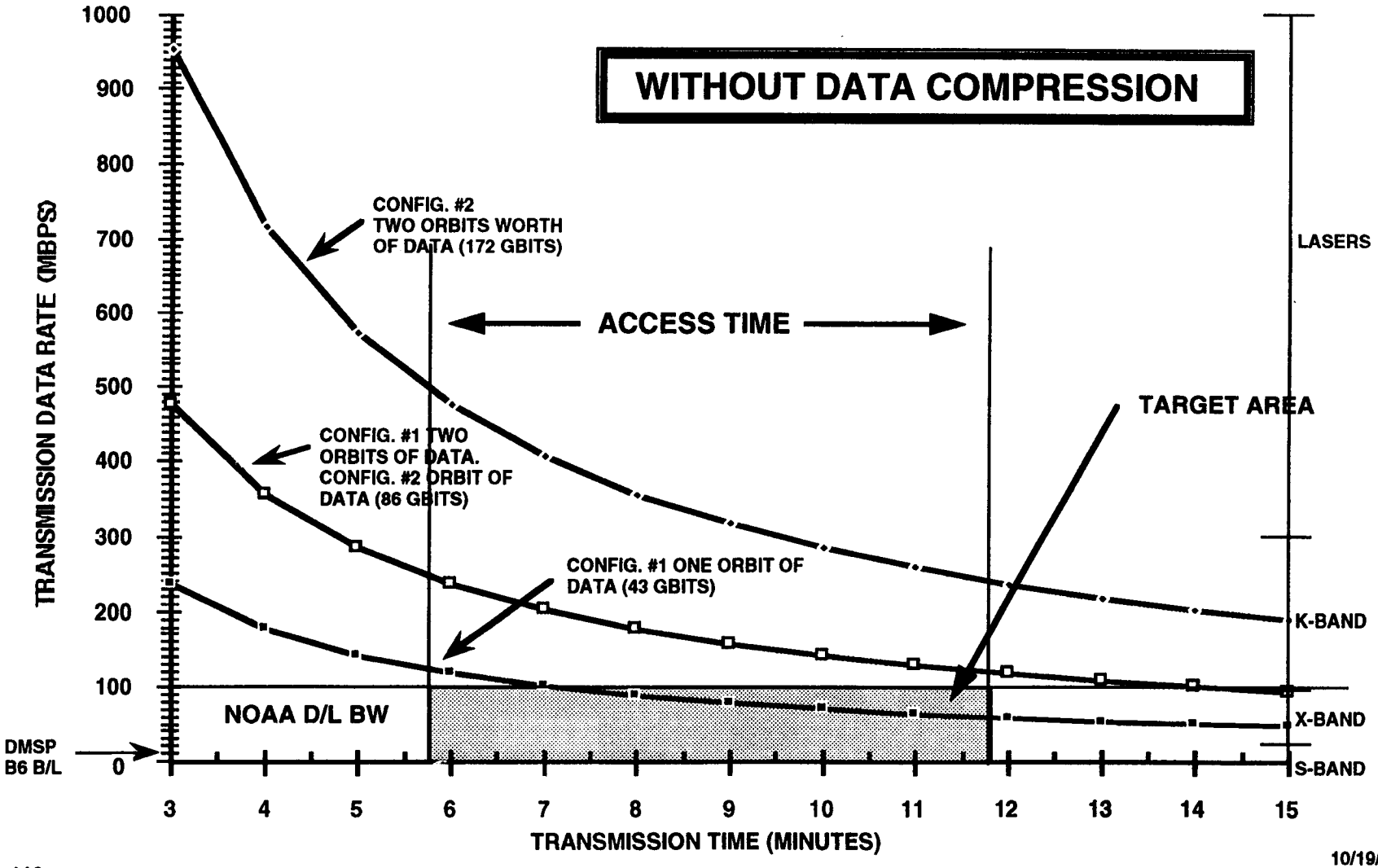
DMSP/POES CONVERGENCE STUDY

CONVERGED CONFIGURATIONS ON-ORBIT STORAGE REQUIREMENTS



***SSM TECHNOLOGY HANDLES 2 -200 GBITS BY 1998**

SMD DOWNLINK DATA RATE VS TIME

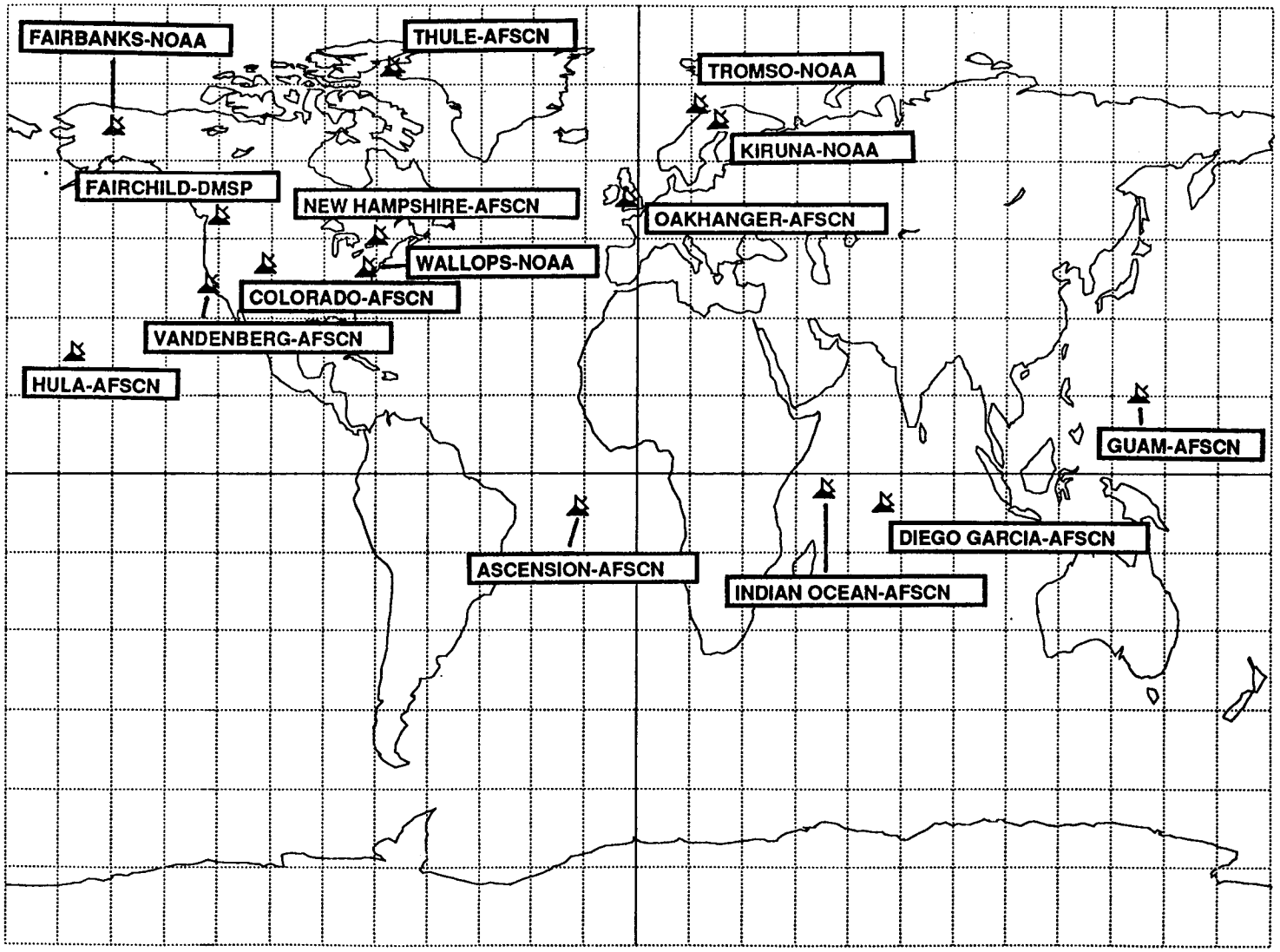


DMSP/NOAA DRR ALTERNATIVES

OPTIONS	1	2	3*	4**	5	6***	7
Description / Location	Minimal Merged System	Robust Merged System	AFSCN Only	NOAA w/ AFSCN Backup	NOAA w/ Foreign Backup	Converged GEO Crosslink	Modified AFSCN Option
Thule	X	X	X	X			X
New Hampshire			X				X
Hawaii			X				
Oakhanger			X				
Vandenberg or Falcon			X				X
Fairbanks	X	X		X	X		X
Wallops Island				X	X		
Kiruna, Sweden		X			X		

* Sites selected as possible configuration. Other AFSCN RTSs may be used.
** AFSCN sites other than Thule may be used to backup NOAA Command Data Acquisition sites for the three daily orbital passes missed by the CDAs.
*** Specify GEO satellite ground control sites if not in the US.

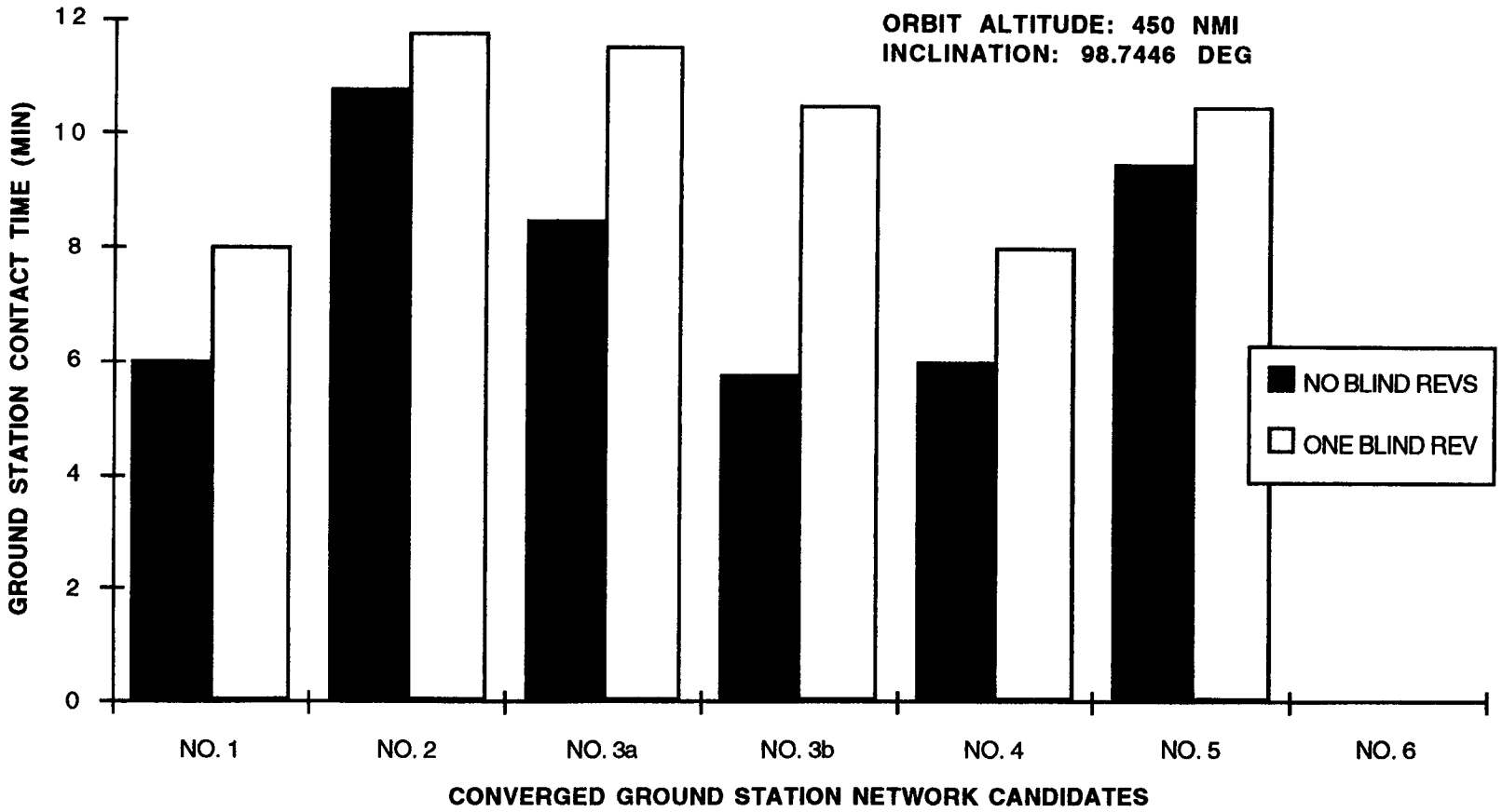
RTS/ CDA LOCATIONS



DMSP/POES CONVERGENCE STUDY

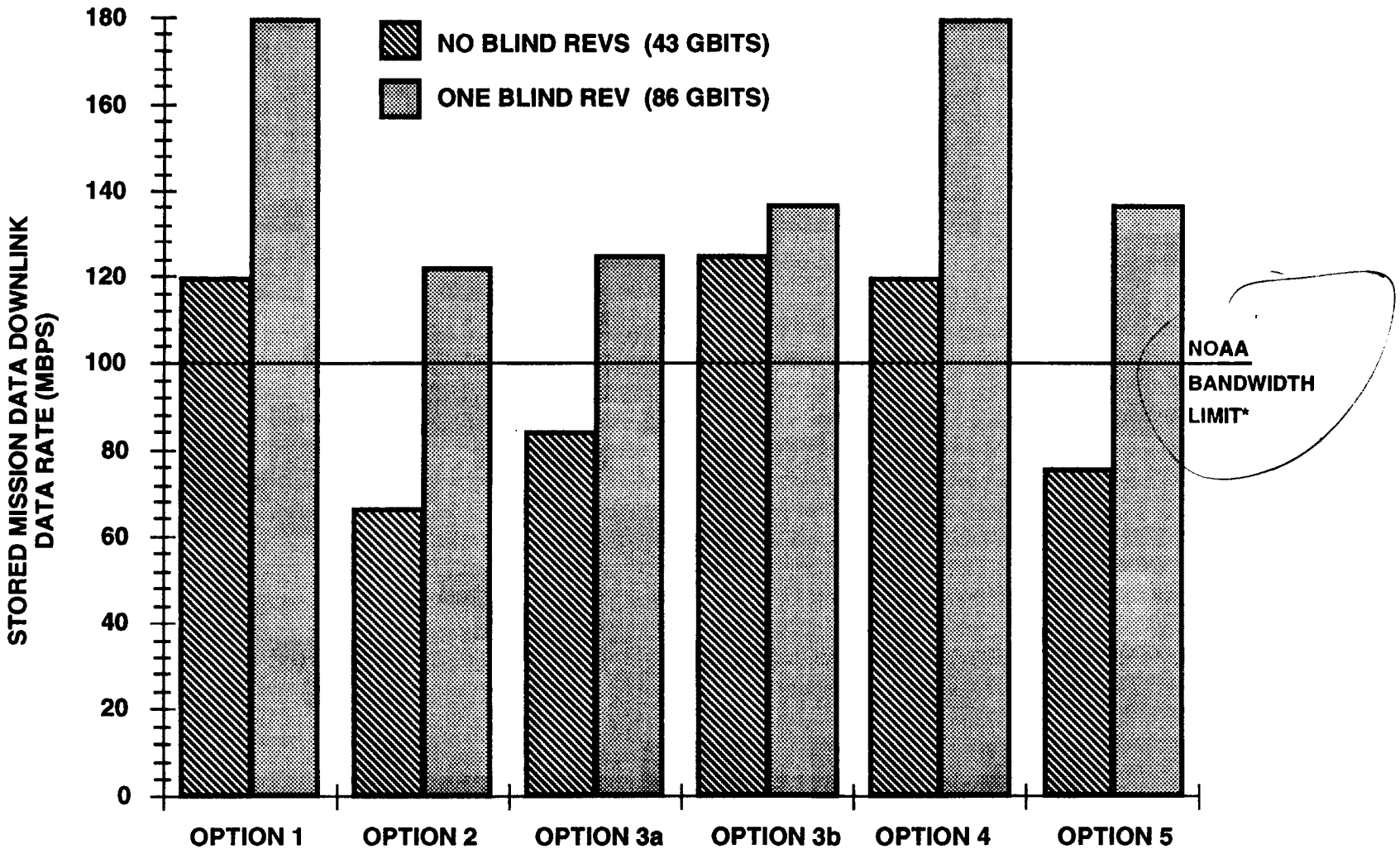
STORED DRR ALTERNATIVES VISIBILITY ANALYSIS RESULTS

MAXIMUM ALLOWABLE CONTACT TIMES FOR CONVERGED GROUND STATION NETWORK CONFIGURATIONS



DMSP/POES CONVERGENCE STUDY

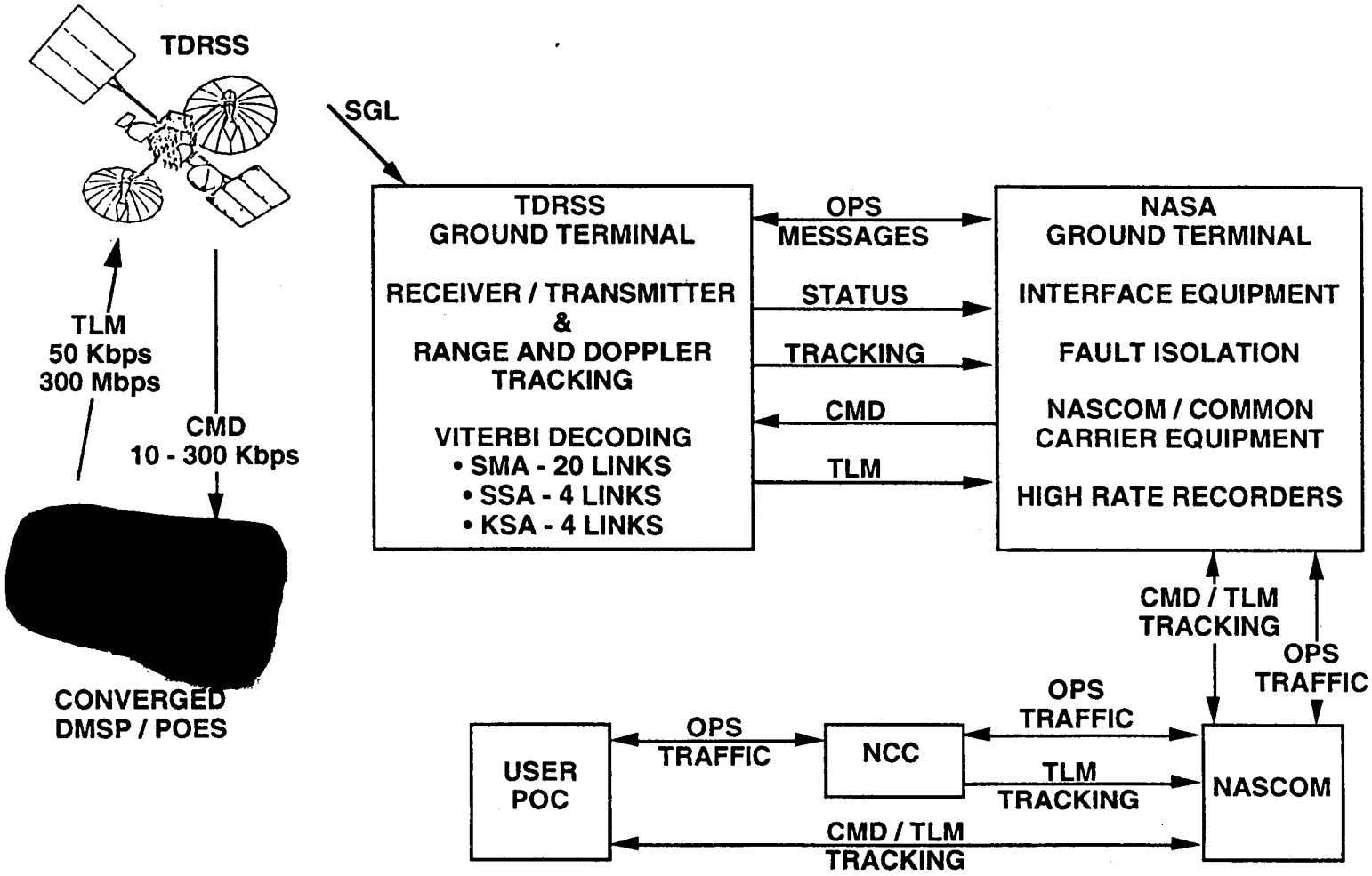
DERIVED DATA RATES FOR PAYLOAD CONFIGURATIONS EXCLUDING THE MODIS



* REFERENCE: NOAA O,P,Q PHASE A REPORT; 29 JAN 92

OPTION 6 - GEOSTATIONARY CROSSLINK

TDRSS DATA FLOW TO USERS



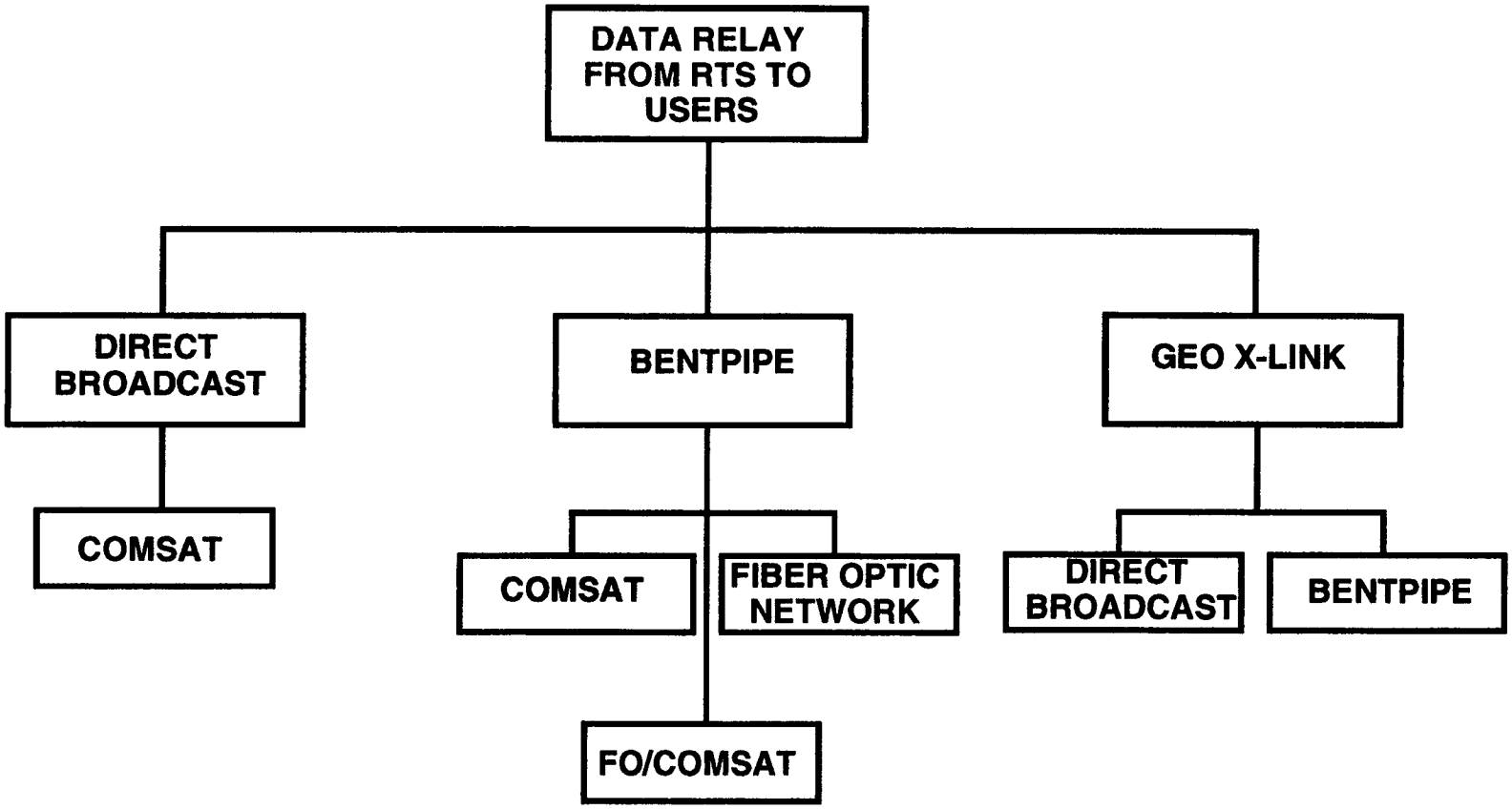
GEO X-LINK ALTERNATIVES

CANDIDATE	FREQUENCY	DATA RATE	ZONE OF EXCLUSION (ZOE)	COST
TDRSS	S, Ku, Ka	50 - 500 Mb	4 - 7 min. @ 833km*	Low
GOES LINK	X, Ku, Ka, W	25 - 750 Mb	>10 min.**	High
MIL RELAY	W	50 - 270 Mb 25 - 750 Mb	TBD	Low
INTERNATIONAL METSAT LINK	X, Ku, Ka, W		NONE***	Moderate

* Based on TDRS locations of 41° & 171° W
** Based on GOES locations of 85° & 135° W
*** 3rd (European) S/C eliminates ZOE

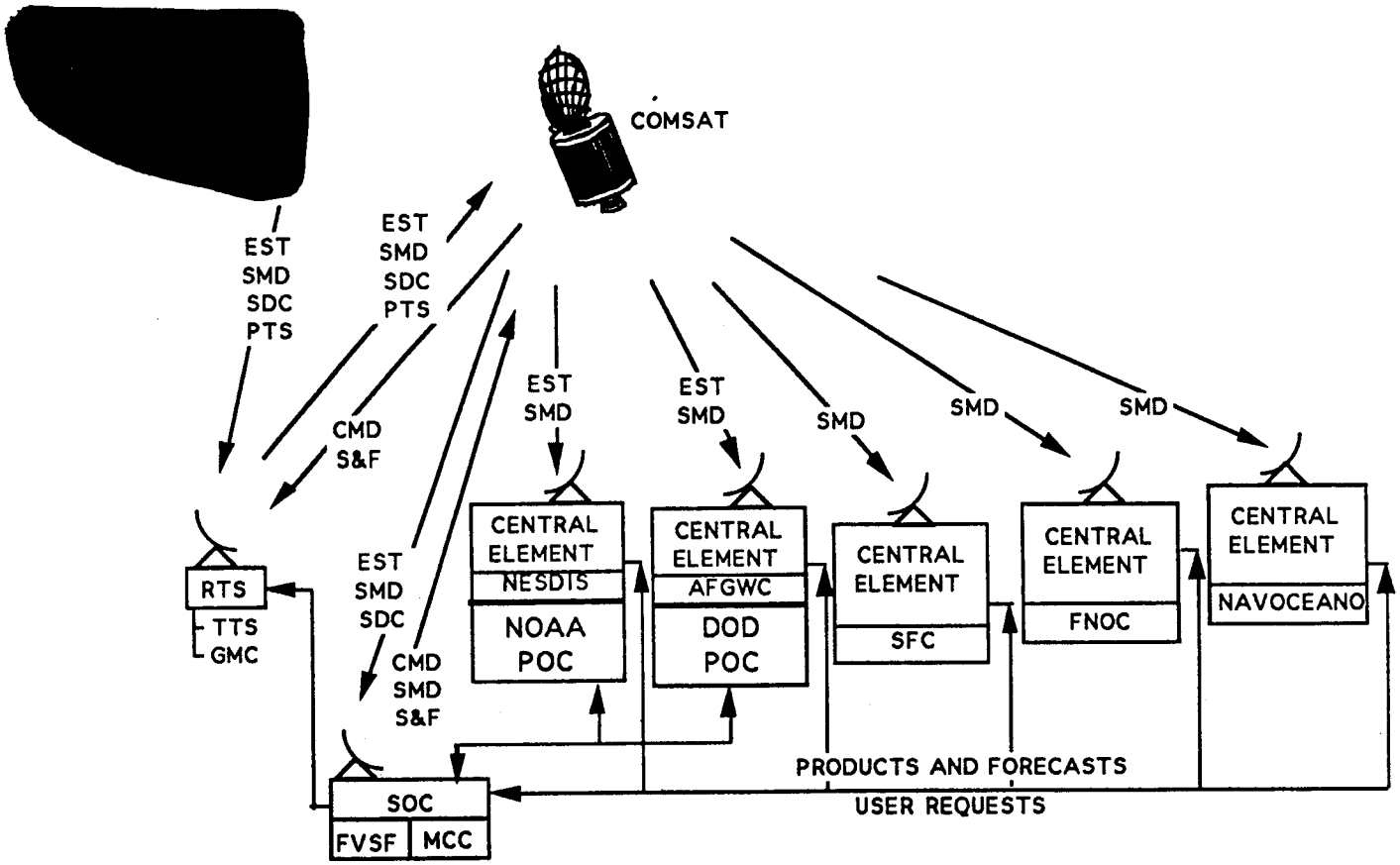
TDRSS COST:
$180 / min. guaranteed contact time
$110 / min. assured contact

DATA RELAY FROM RTS TO USERS



DIRECT BROADCAST: RELAYED DIRECTLY FORM RTS/CDA TO THE USER SITES.
BENTPIPE: RELAYED FROM THE RTS TO A SINGLE NODE FOR DISTRIBUTION TO USERS

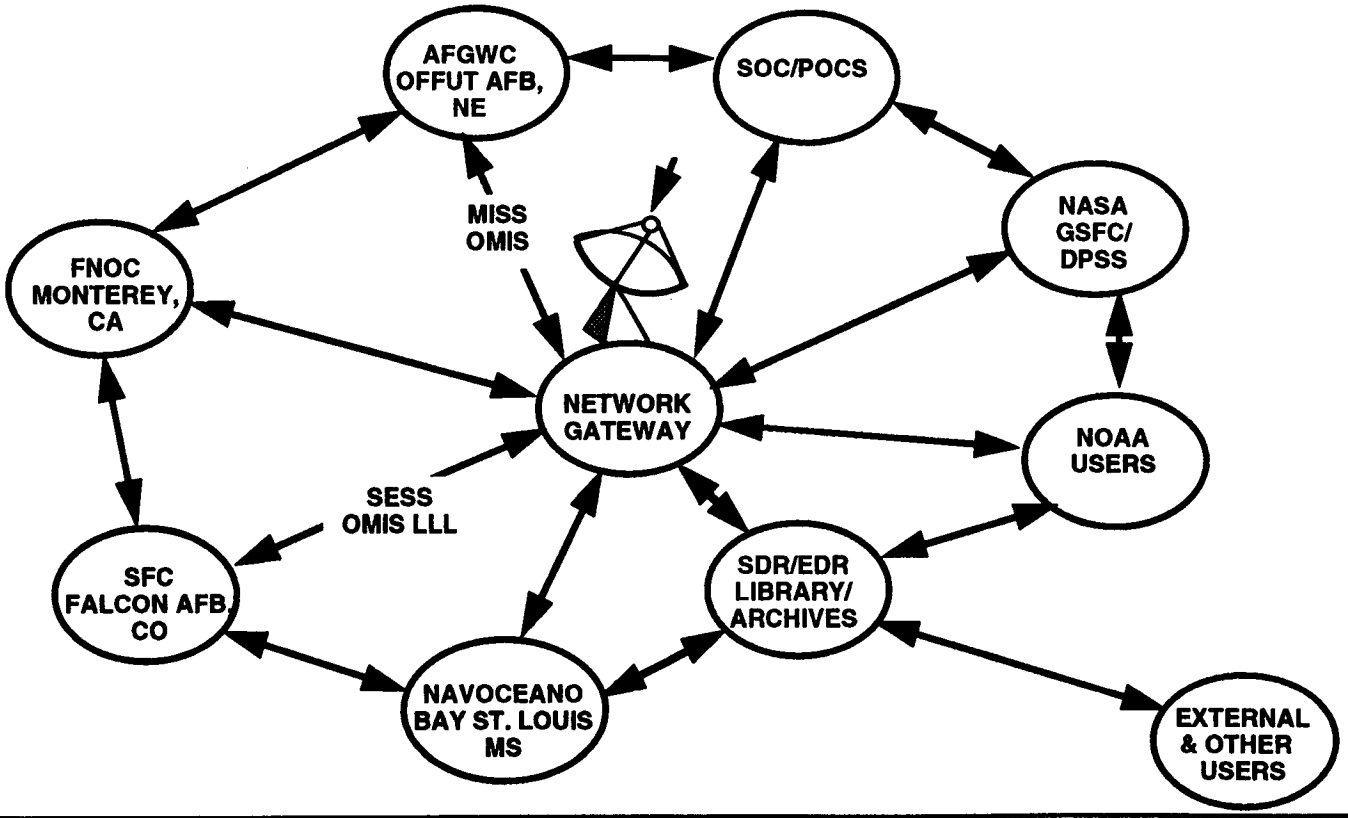
DIRECT BROADCAST DATA DISTRIBUTION



DMSP/POES CONVERGENCE STUDY

"BENTPIPE"/DISTRIBUTED NETWORK APPROACH

- SATELLITE DATA ENTERS DATA DISTRIBUTION NETWORK THRU GATEWAY
- SENSOR DATA RECORDS ARE PACKAGED, AND DISTRIBUTED TO USERS OVER THE NETWORK
- DATA PACKAGED ARE DEVELOPED BASED ON USERS REQUIREMENTS AND AREAS OF EXPERTISE
- ALL USERS HAVE "ON-LINE" ACCESS DATA PRODUCTS PROCESSED AT OTHER SITES



DISTRIBUTED PROCESSING OF THE CONVERGED SYSTEM'S MISSION DATA CAN MINIMIZE IMPACTS TO USER SITE EQUIPMENT AND OPERATIONS

KTA TRADE FACTORS

Parameter	Weight Factor	Minimal System	Robust System	AFSCN	NOAA w/ AFSCN Backup	NOAA /w Foreign Backup	GEO Crosslink		Mod AFSCN
							TDRSS	X-LINK	
Hardware Upgrade									
Data Routing									
Data Format									
Data Compression									
Data Rate									
Timeliness									
Security									
Transition (Block 5D&NOAA K,L,M)									
Site Upgrade Cost									
O & M									
Schedule									
Availability									
TOTAL									

IMPACT FACTORS WEIGHTING

PARAMETER	SIGNIFICANT	MODERATE	LOW
Hardware Upgrade	Total replacement of element is required	Major replacement of components is required	Hardware planned or in-place
Interface Complexity	Multiple interfaces	Duplicate interfaces	Common interface
Data Routing	>3 times present capability	2 times present capability	Within existing design capabilities
Timeliness	Several gaps in coverage	Meet requirement with some gaps	Exceeds requirement, visible every orbit
Security	International sites	Civil sites	Controlled sites
Block 5D Transition	Dual capability required, difficult to integrate	Ops integrated w/ reduced dual capability	No dual capability required, single operations
Site Upgrade Cost	Replacement of existing capability (Multi upgrades)	Upgrade existing sites (<3 site upgrade)	Existing capability (In-place or planned)
O & M	>$60 M	>$30 M	<$30 M
Schedule	High risk to converged program schedule	Medium risk to schedule	Low risk to schedule
Availability	No guarantee of support	No backup support	No conflicts

SOC CONFIGURATION ALTERNATIVES

- SOC ALTERNATIVE CONFIGURATIONS

OPTIONS	1	2	3	4
Description / Location	DOD Ops	NOAA Ops	Independent Gov't Agency	DoD / NOAA Shared Ops
Falcon AFB, CO	X			X
Suitland, MD		X		X
Other			X	

- EXISTING BLOCK 6 CONFIGURATION
  - BASELINE CONFIGURATION
- SOC TRADE ATTRIBUTES
- USE OF OF ADVANCE TECHNOLOGY TO EASE TRANSITION, AND LOWER PERSONNEL REQUIREMENTS

BLOCK 6 DATA ROUTING & RETRIEVAL ADAPTABLE TO SOC LOCATION

INITIAL BLOCK 6 CONFIGURATION:

PRIMARY	FSOC
BACKUP	CSOC

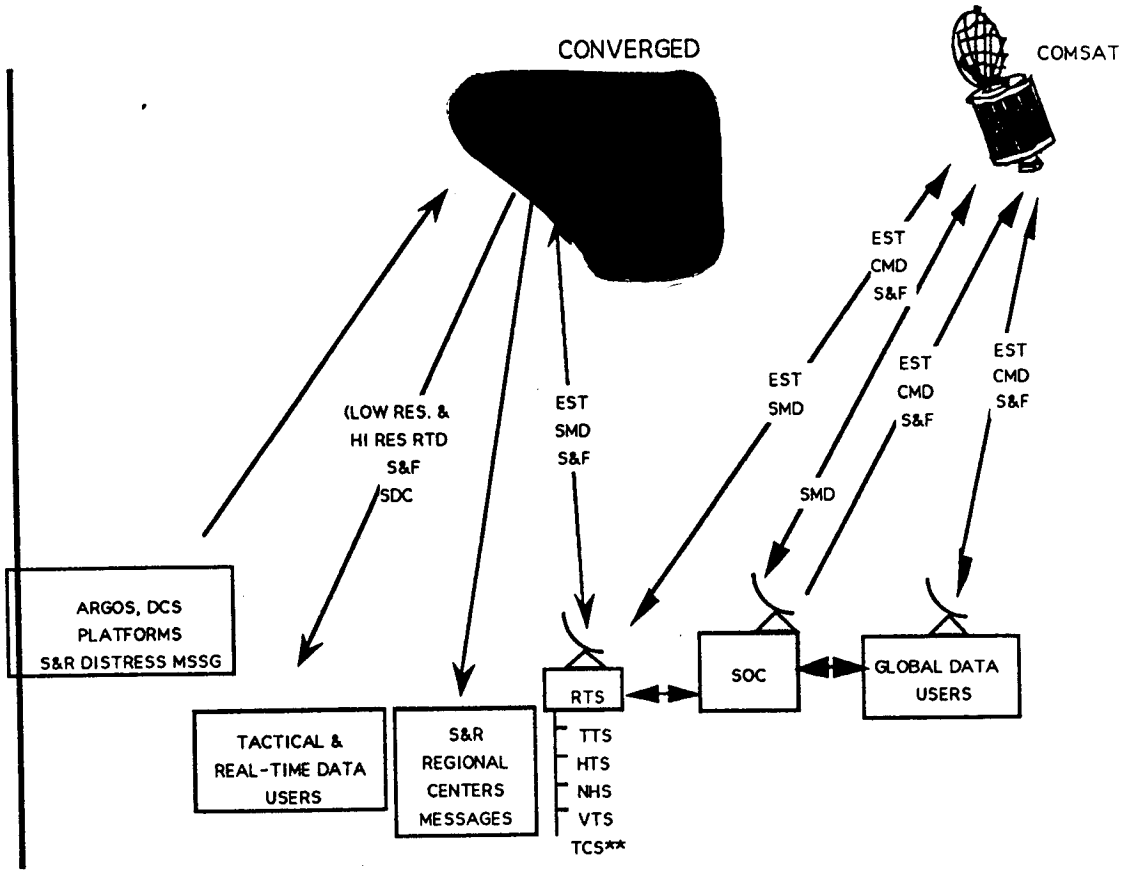
CURRENT CONFIGURATION

PRIMARY	MPSOC
BACKUP	FSOC
TERTIARY	CSOC

LIKELY FUTURE CONFIGURATION

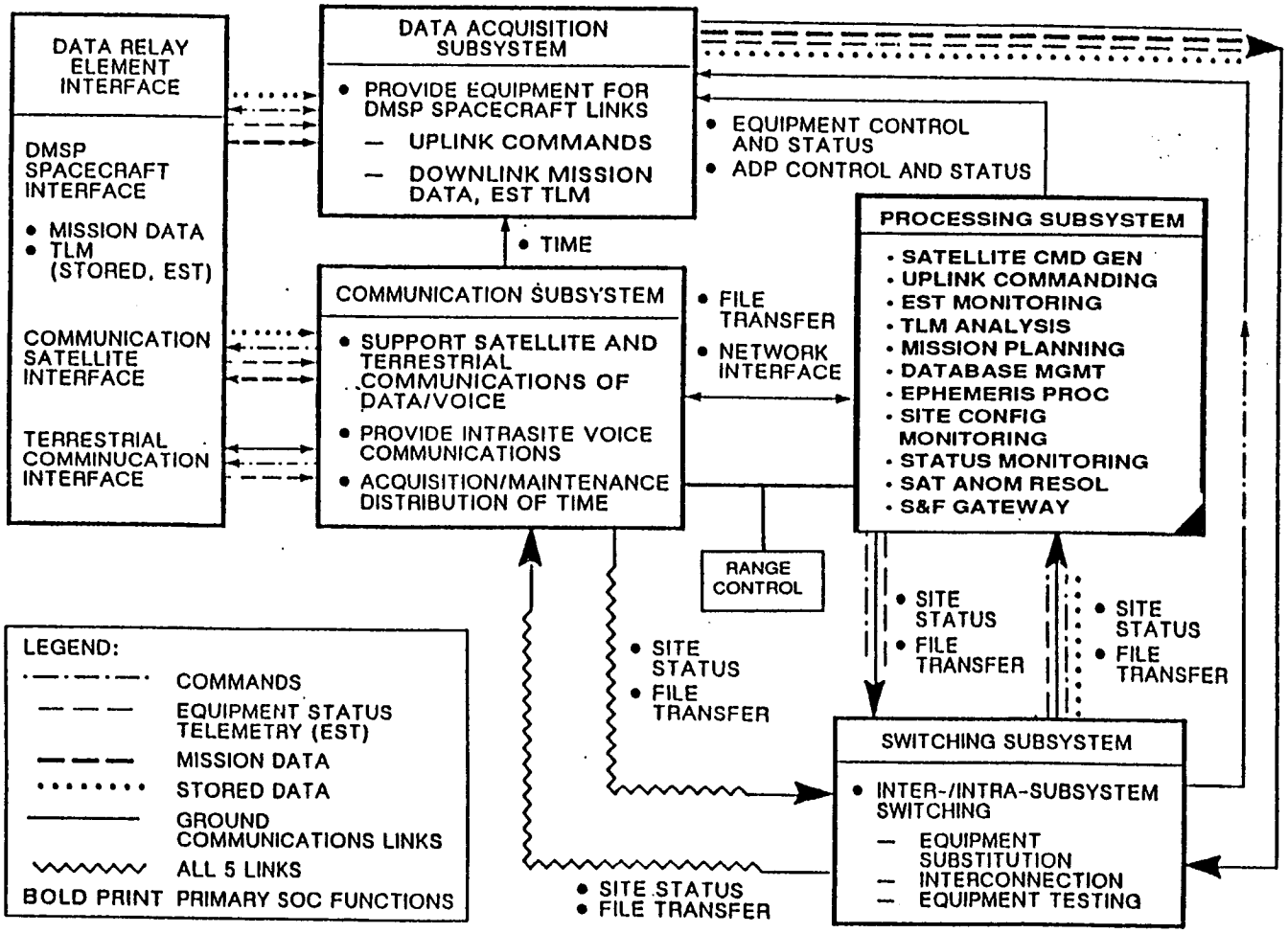
-

PRIMARY	CSOC
BACKUP	MPSOC



BASELINE DATA RELAY CONCEPT IS INSENSITIVE TO SOC LOCATION

NOMINAL AFSCN SOC FUNCTIONS



◢ TAILORED FOR DMSP-6

TECHNOLOGY INSERTION CAN REDUCE STAFFING / EASE TRANSITION

- REDUCE THE NUMBER OF OPERATOR/ANALYSTS REQUIRED BY MAXIMIZING USE OF RULE ORIENTED SOFTWARE TO PERFORM ROUTINE ANALYSIS
  - CAPTURE THE OLD HANDS EXPERTISE
  - HAVE ANALYSTS HANDLE THE EXCEPTIONS
- MAXIMIZE THE CROSS TRAINING OF PERSONNEL/REDUCE TRAINING TIME
  - HAVE FEWER MORE CAPABLE PEOPLE
- STREAMLINE COMMAND AND CONTROL SOFTWARE
  - MAXIMIZE USE OF COMMERICIAL OFF THE SHELF SOFTWARE TO MINIMIZE DEVELOPMENT
- UPGRADE AN EXISTING SOC CAPABILITY TO HANDLE 5D-3, NOAA M, N, N', CONVERGED SYSTEM OPERATIONS, AND OTHER RELATED MISSIONS

DMSP/POES CONVERGENCE STUDY

SOC LOCATION TRADE CRITERIA

WANTS	WEIGHT	CSOC	SUITLAND	OTHER	DUAL OPS CSOC/SUIT
EASE OF TRANSITION (2 -3-1 SYSTEMS)					
MAXIMUM USE OF EXISTING FACILITIES					
MAXIMUM USE OF EXISTING O&M SUPPORT STRUCTURE					
MINIMIZE OPERATIONAL PERSONNEL					
MINIMIZE LIFE CYCLE COST					
RESPONSIVENESS TO USER OPERATIONAL & MISSION REQUIRE-MENTS (DOD, DOC)					
EASE OF INTEGRATION WITH THE SELECTED DRR CONFIGURATION					
MAXIMUM FLEXIBILITY FOR INSERTION OF ADVANCED C2 TECHNOLOGY					

DMSP/POES CONVERGENCE STUDY

LOCKHEED RULE BASED SYSTEMS ACTIVITIES

- LSTAR 1985, LOCKHEED EXPERT SYSTEMS DEVELOPMENT - RTWORKS (COTS)
- IPAS 1989, (SUN WORKSTATION & EXPERT SYSTEMS USED TO PROCESS SATELLITE TELEMETRY DATA)
  - ADAPTED FOR USE ON CRRES
- IPGS 1992, (COMMANDING ADDED TO IPAS)
  - SYSTEM DEMONSTRATION PERFORMED WITH DSCS II
  - SYSTEM DEVELOPED & DEMONSTRATED IN 2 MONTHS
  - FULL SYSTEM VALIDATION USING STEPS
- RSC STUDY 1993 (CWI) - LOWER COST C^2 FOR PHILLIPS LAB
- RT-WORKS BASED TLM ANALYSIS SYSTEM FOR HST IS OPERATIONAL AT GODDARD
  - SIMILAR TYPE OF SYSTEM DEVELOPED FOR MILSTAR OPS
  - PLANNED TO FSAT SYSTEM TEST ACTIVITY
- INTERNAL RESEARCH & DEVELOPMENT EFFORTS
  - SINGLE PLATFORM FOR TELEMETRY ANALYSIS OF MULTIPLE SPACE SYSTEMS
    - - DEMONSTRATED WITH DMSP 5D-2 AND FLTSATCOM (90-91)
  - RT-WORKS BASED C^2 SYSTEM FOR FLTSATCOM, RULES WRITTEN TO INCORPORATE OPERATIONAL EXPERTISE (1993)

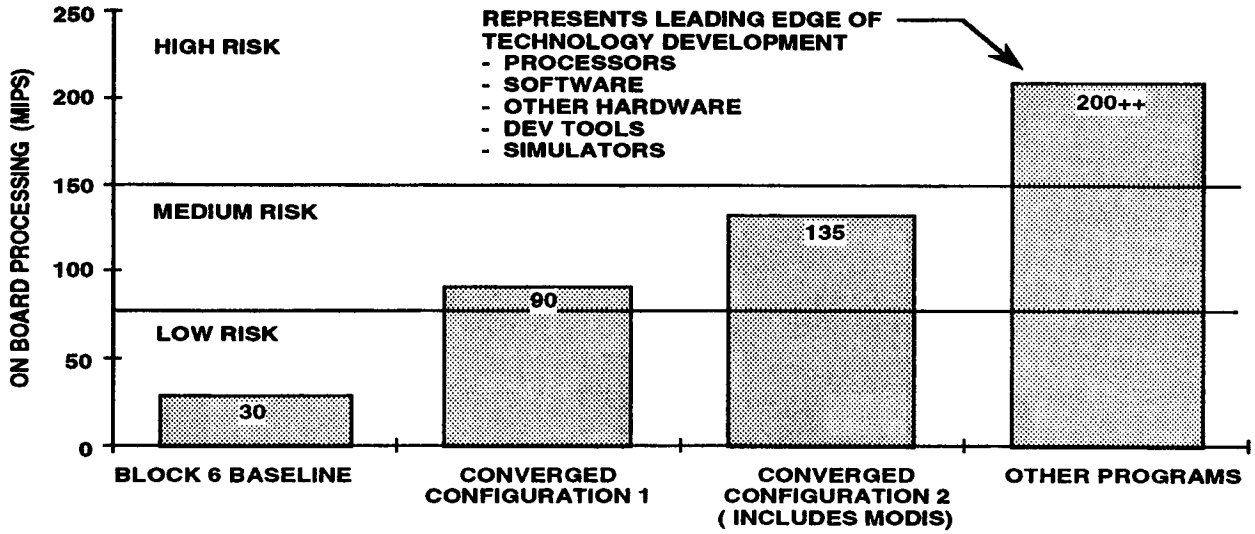
DMSP/POES CONVERGENCE STUDY

HIGH DATA RATE SYSTEM IMPACTS AND RISKS

ELEMENT	IMPACTS TO BLOCK 6 BASELINE	MITIGATING TECHNOLOGY
SPACE SEGMENT		
• ON-BOARD PROCESSING	- ONBOARD STORAGE INCREASES FROM 10 GBITS TO 86 - 172 GBITS - MISSION DATA PROCESSING INCREASES FROM 30 MIPS TO 90 - 135 MIPS	DATA COMPRESSION PARTIAL READOUTS CROSSLINKS
• COMMUNICATIONS	- INCREASES NUMBER OF REAL-TIME D/Ls - INCREASES THROUGHPUT & COMPLEXITY OF THE STORED MISSION DATA D/L	DATA COMPRESSION CROSSLINKS
C3. DATA ROUTING		
• RTS/CDA's	- REQUIRES INSTALLATION OF X-BAND ANTENNAS & ELECTRONICS	SEPARATE DOWNLINKS DATA COMPRESSION
• RELAY TO USERS	• REQUIRES RELAY WITH A DATA THROUGHPUT OF 45 - 90 MBPS	CROSSLINKS
USER SEGMENT I/F		
• I/F PROCESSING (FRONT END) • DATA STORAGE & ARCHIVES	- INCREASES DATA INGEST REQUIREMENTS FROM 10 MBPS PER DATA STREAM TO 45 -90 MBPS - INCREASES DATA STORAGE BY A FACTOR OF 4	DATA COMPRESSION CROSSLINKS

DMSP/POES CONVERGENCE STUDY

ON BOARD PROCESSING RISK ASSESSMENT

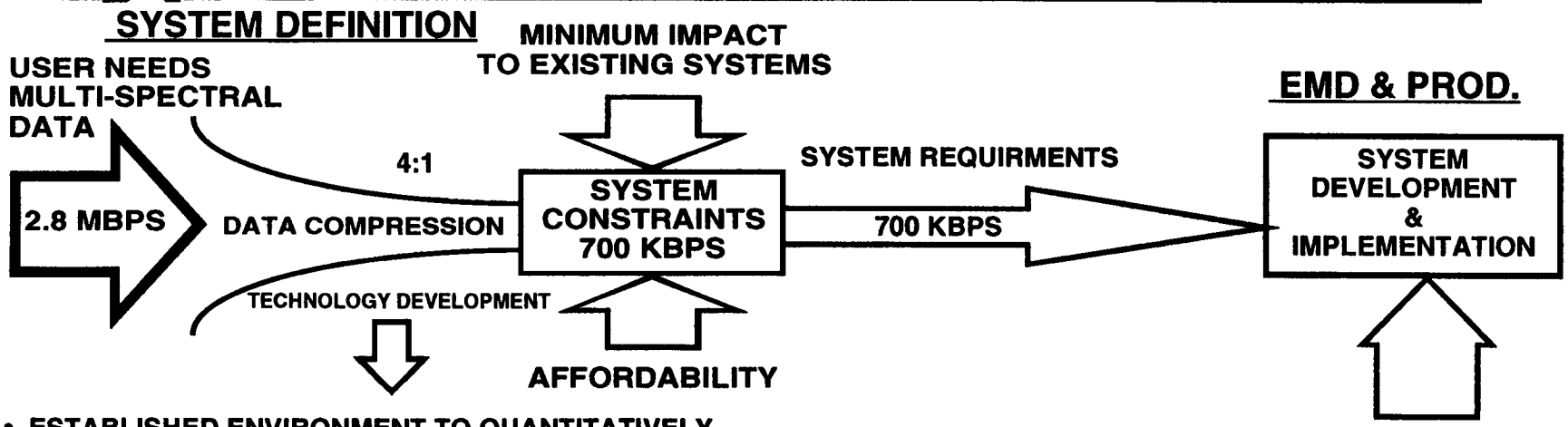


RISK LEVELS ARE BASED ON 5 YEAR TECHNOLOGY FORECAST

MISSION DATA PROCESSING RISK AREAS	CAUSE	IMPACTS TO SCHEDULE AND COST	MITIGATION
• HIGHER INPUT DATA RATES & VOLUME • HIGHER DATA COMPRESSION RATIOS • MORE OUTPUT DATA STREAMS (SSM, D/Ls) • MULTIPLE COMPRESSION SCHEMES & FORMATS	• MULTIPLE SENSORS W/ HIGH DATA RATES • D/Ls DATA RATE LIMITED • ADDITIONAL USERS DOWNLINKS	• INCREASES DEVELOPMENT COMPLEXITY • INCREASES MDP SIZE, COMPLEXITY, & COSTS • INCREASED S/W COMPLEXITY (FOR PARALLEL PROCESSORS)	• USE FUNCTIONS SPECIFIC HARDWARE (ASICS, DSP) • FASTER PROCESSORS • ADVANCED PROCESSORS (64 BIT) • LARGER AND FASTER PROCESSOR MEMORIES • CROSSLINKS

DMSP/POES CONVERGENCE STUDY

BLOCK 6 RELATED DATA COMPRESSION ACTIVITY



- ESTABLISHED ENVIRONMENT TO QUANTITATIVELY ASSESS IMPACTS OF DATA COMPRESSION ON EDR ALGORITHM
- DEVELOPED AND EVALUATED MULTI-CHANNEL ALGORITHMS
- EVALUATED CLOUD DETECTION, CLOUD TYPING ALGORITHMS AT PIXEL LEVEL (LIMITED DATA SCENES)

COMPRESSION RATIO	CLOUD DETECTION	CLOUD TYPING
4:1	99.8%	98.1%
8:1	99.7%	97.5%
16:1	99.6%	96.8%

- CONTINUE TO EVALUATE DEVELOPED AND OTS COMPRESSION ALOGRITHMS ON EDRs
- USE GLOBAL REPRESENTATIVE SCENES
  - SEASONAL CHANGES
  - LATITUDES (POLAR, MID, TROPICS)
  - BACKGROUNDS (LAND, OCEAN, ICE/SNOW)
- USE END-TO-END SYSTEM TEST BED TO DEMONSTRATE RESULTS (CREST)

OTHER PROGRAMS: DOD LANDSAT DATA COMPRESSION STUDY, CRSS

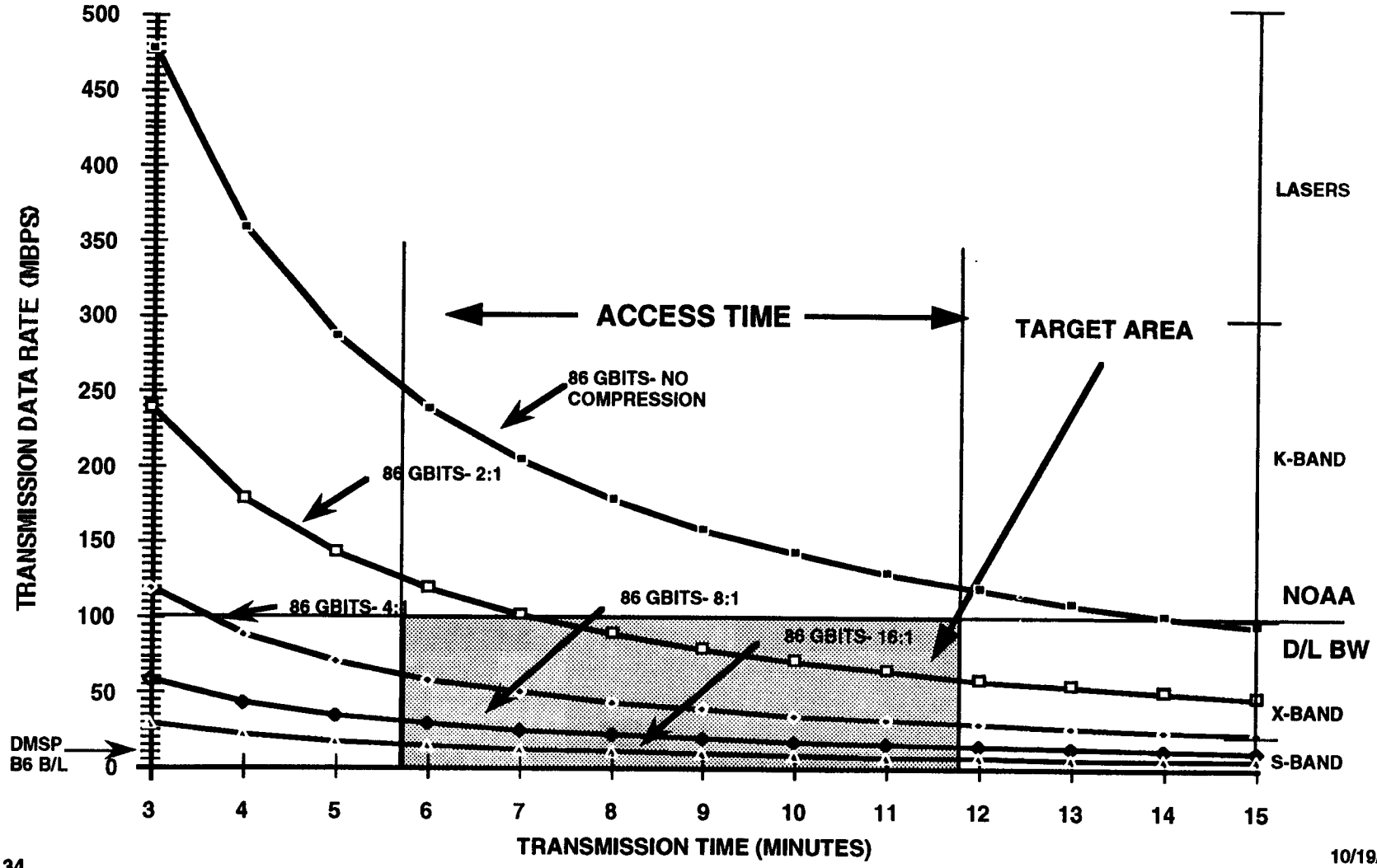
CORPORATE DEVELOPMENT

RISK REDUCTION

IWPTB FUNDED ACTIVITIES

DMSP/POES CONVERGENCE STUDY

IMPACTS OF COMPRESSION ON THE SMD DOWNLINK DATA RATE



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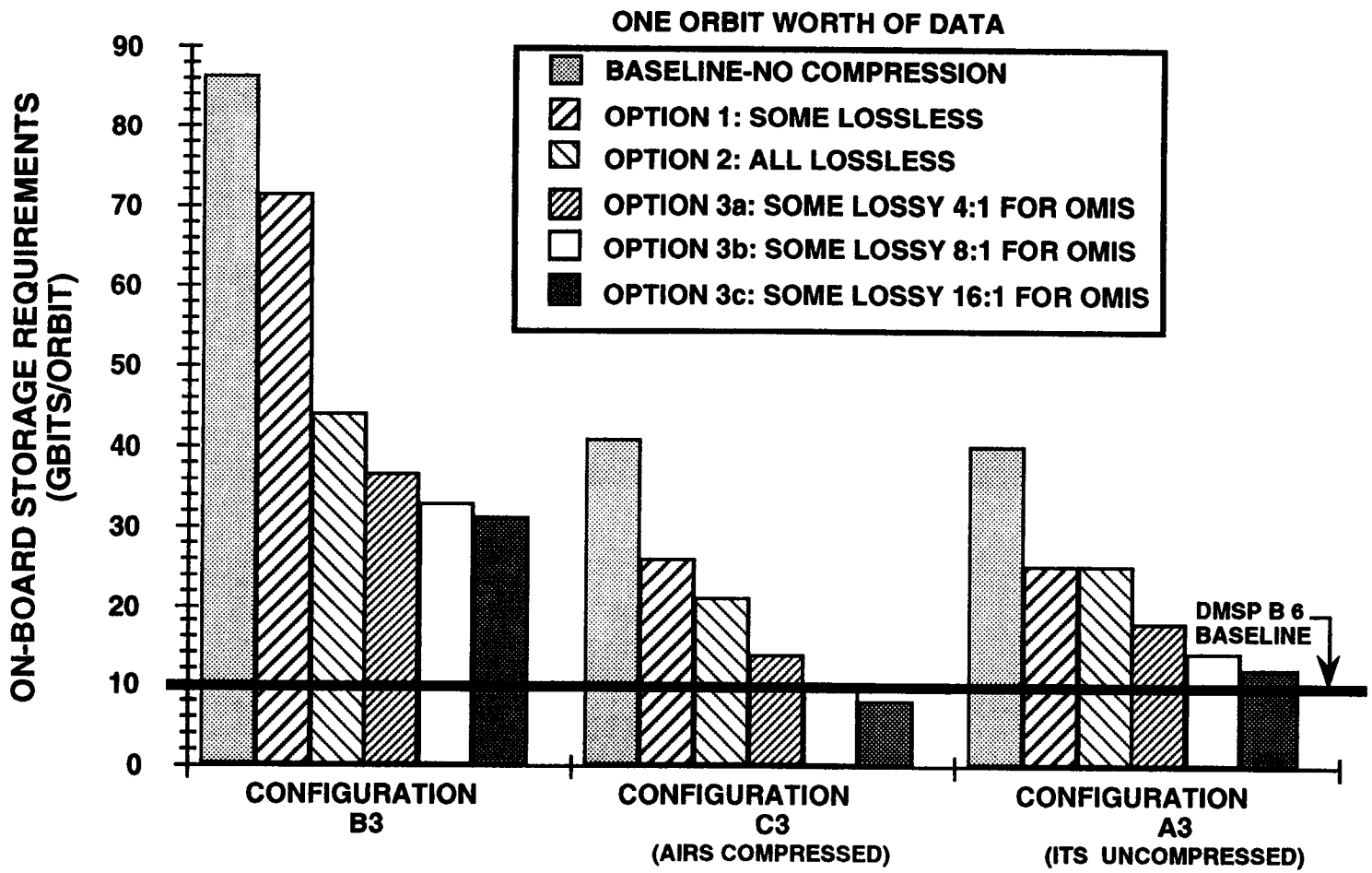
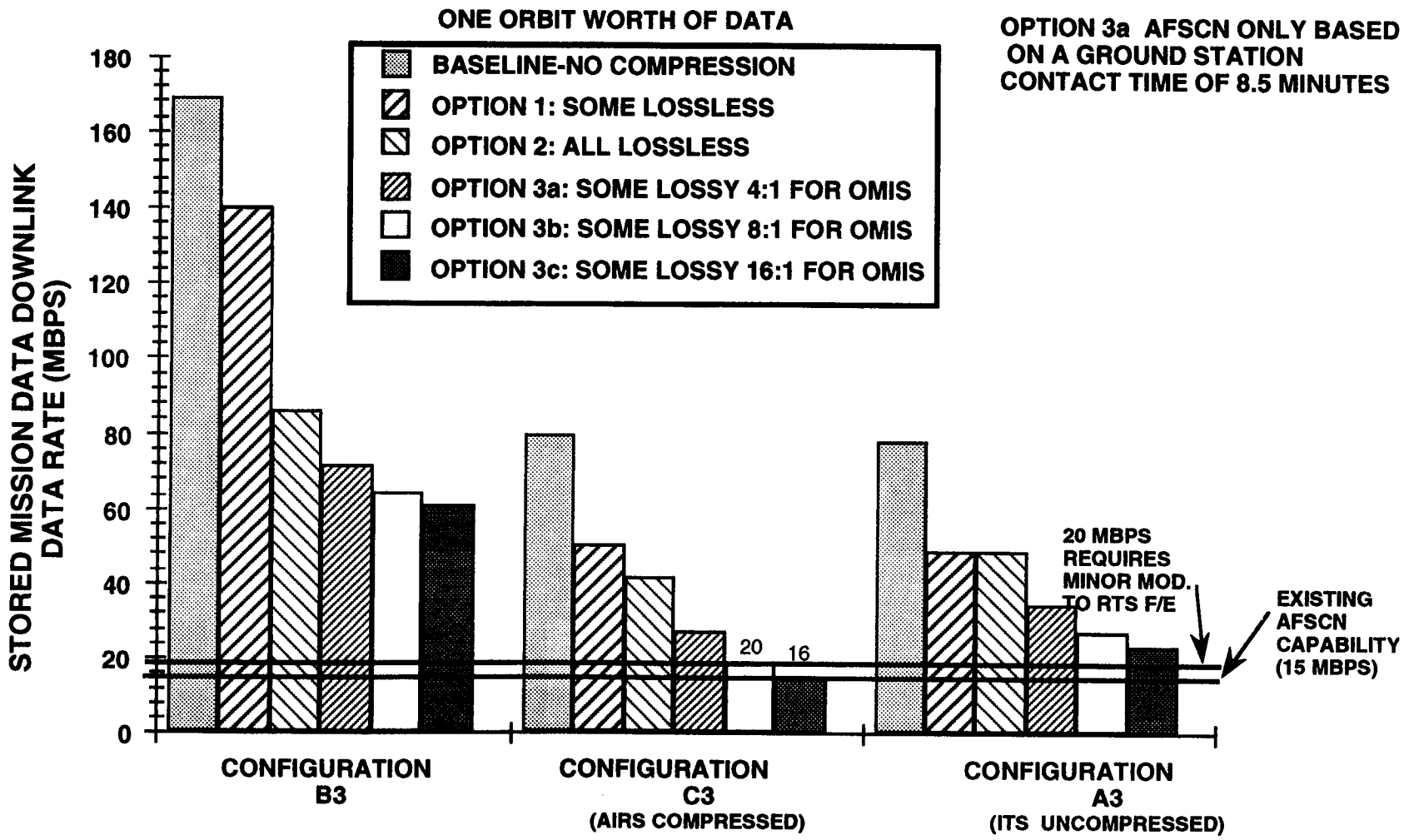
DMSP/POES CONVERGENCE STUDY

IMPACTS OF DATA COMPRESSION ON ON-BOARD STORAGE



DMSP/POES CONVERGENCE STUDY

DATA COMPRESSION IMPACTS ON SMD D/L DATA RATE FOR DRR ALTERNATIVE 3a



DMSP/POES CONVERGENCE STUDY

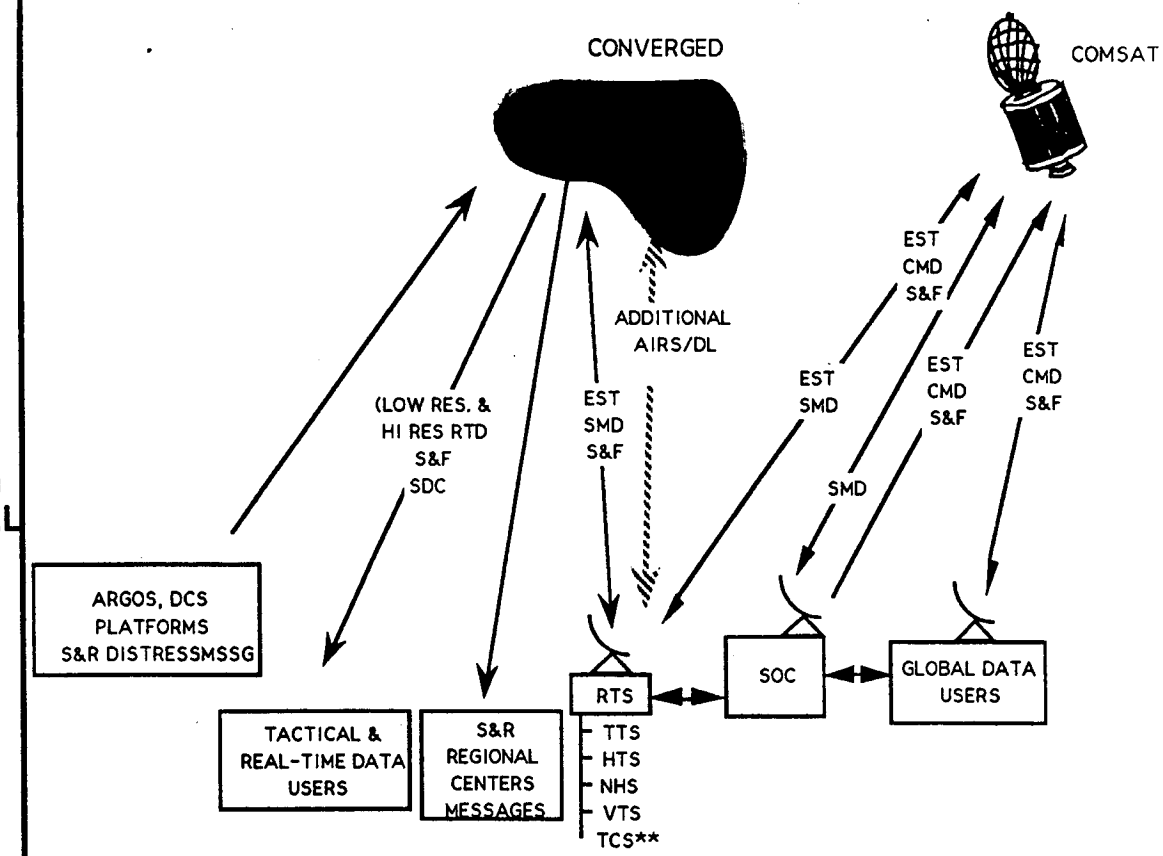
STORED MISSION DATA ROUTING THROUGH THE AFSCN CONCEPT

OPERATIONAL SENSOR DATA (ALL EXCEPT AIRS/ITS)

- DOWNLINKED ON TWO 5 MBPS CHANNELS
- BENT PIPED TO GLOBAL USERS

AIRS/ITS DATA (COMPRESSED)

- DOWNLINKED ON SEPARATE CHANNELS
- ARTS CAPABLE OF SUPPORTING AN ADDITIONAL 5 MBPS CHANNEL (QPSK); UP 10 MBPS W/MINOR MODS
- DATA RECORDED AT RTS
- TRANSMITTED TO CENTRAL USERS AFTER OPERATIONAL DATA TRANSMISSION
- REQUIRES ADDITIONAL BW ALLOCATION AT S-BAND, RFI STUDY (OTHER PROGRAMS)



RFI -- A SYSTEMS APPROACH

- SYSTEM /SPACE SEGMENT LEVEL
  - REQUIREMENTS ANALYSIS IDENTIFIES POTENTIAL INTERFACE AND INTER-PAYLOAD COMPATIBILITY ISSUE
  - REQUIREMENT FLOWDOWN ESTABLISHES DESIGN CRITERIA/ GUIDELINES TO INSURE COMPATIBILITY
  - SPACE VEHICLE LEVEL
    - ANTENNA FIELD OF VIEW CONSIDERATIONS & KEEP OUT ZONES FOR EQUIPMENT LAYOUTS*
    - SUBSYSTEM/COMPONENT LEVEL
      - ANTENNA BEAM PATTERN SHAPED TO FOV REQUIREMENTS
      - BANDPASS AND STOP BAND FILTERS IN FRONT-END ELECTRONICS AND/OR IN ANTENNA DESIGNS
- COMPATIBILITITY VERIFIED WITH ANALYSIS AND TESTING

* 48" BETWEEN SAR AND CMD U/L GIVE 40 dB ISOLATION

DRR/ C^2 SUMMARY

- HIGH DATA RATE A SYSTEM RISK DRIVER
  - SIGNIFICANTLY INCREASES ON-BOARD STORAGE & PROCESSING REQUIREMENTS
  - LARGE BANDWIDTH DOWNLINKS REQUIRE SIGNIFICANT MODIFICATION TO EXISTING GROUND COMMUNICATIONS STATIONS
  - IMPACTS USER SITE FRONT-END PROCESSING
  - INCREASES DATA RELAY COSTS
- COMMAND & CONTROL
  - SOC LOCATION NOT AS IMPORTANT AS ROBUSTNESS AND FLEXIBILITY
  - SOC CO-LOCATED WITH OTHER SOCs CAN SHARE RESOURCES
  - SINGLE SOC OPERATION INHERENTLY LOWER COST

- MISS DATA REFRESH
- IWPTB APPROACH
- SYSTEM RISK SUMMARY
- BRIEFING SUMMARY

DAVE PAUL

COMMON MISS TASKING

* FOR 833 KM ALTITUDE:
  - CONTRACTOR-SELECTED EARTH INCIDENCE ANGLE
  - GOAL OF BEST REFRESH POSSIBLE BASED ON CONTRACTOR-SELECTED EARTH INCIDENCE ANGLE, ASCENDING NODE, AND PHASING (EXAMINE RANGE OF OPTIONS)
  - MEETS HORIZONTAL SPATIAL RESOLUTION REQUIREMENTS

FOR CONTRACTOR BASELINE ALTITUDE:
  - MISS SHALL BE CONTRACTOR BASELINE MISS
    - CONTIGUOUS COVERAGE
    - MEETS HORIZONTAL SPATIAL RESOLUTION REQUIREMENTS

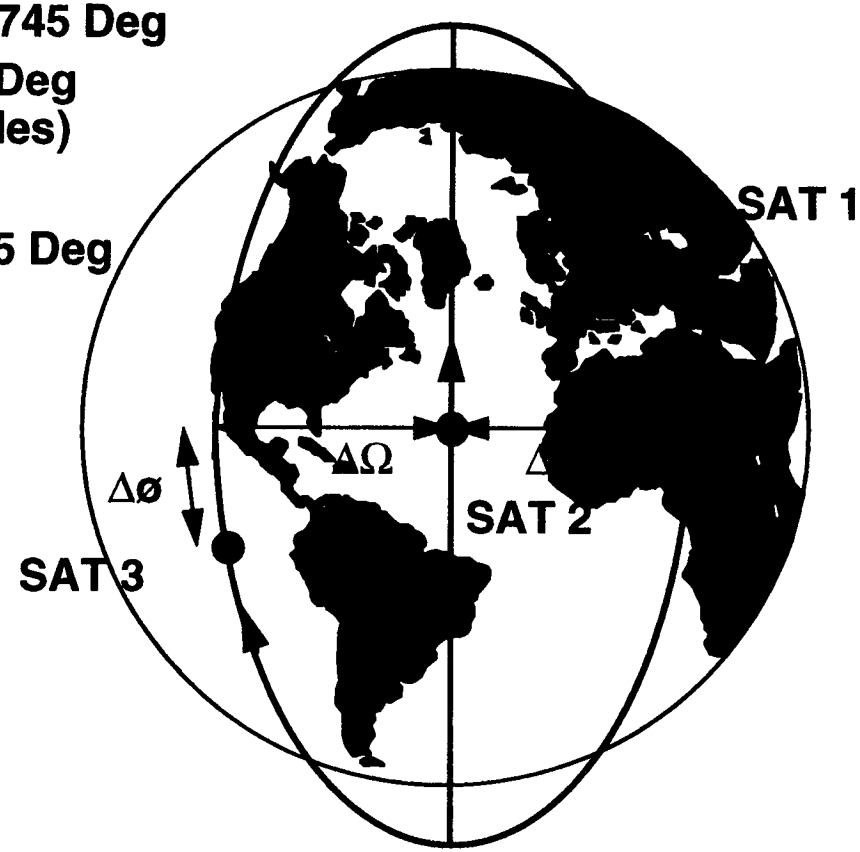
THREE-SATELLITE CONSTELLATION PARAMETERS

Circular Orbit Altitude = 450 NMI

Sun-Synchronous Inclination = 98.745 Deg

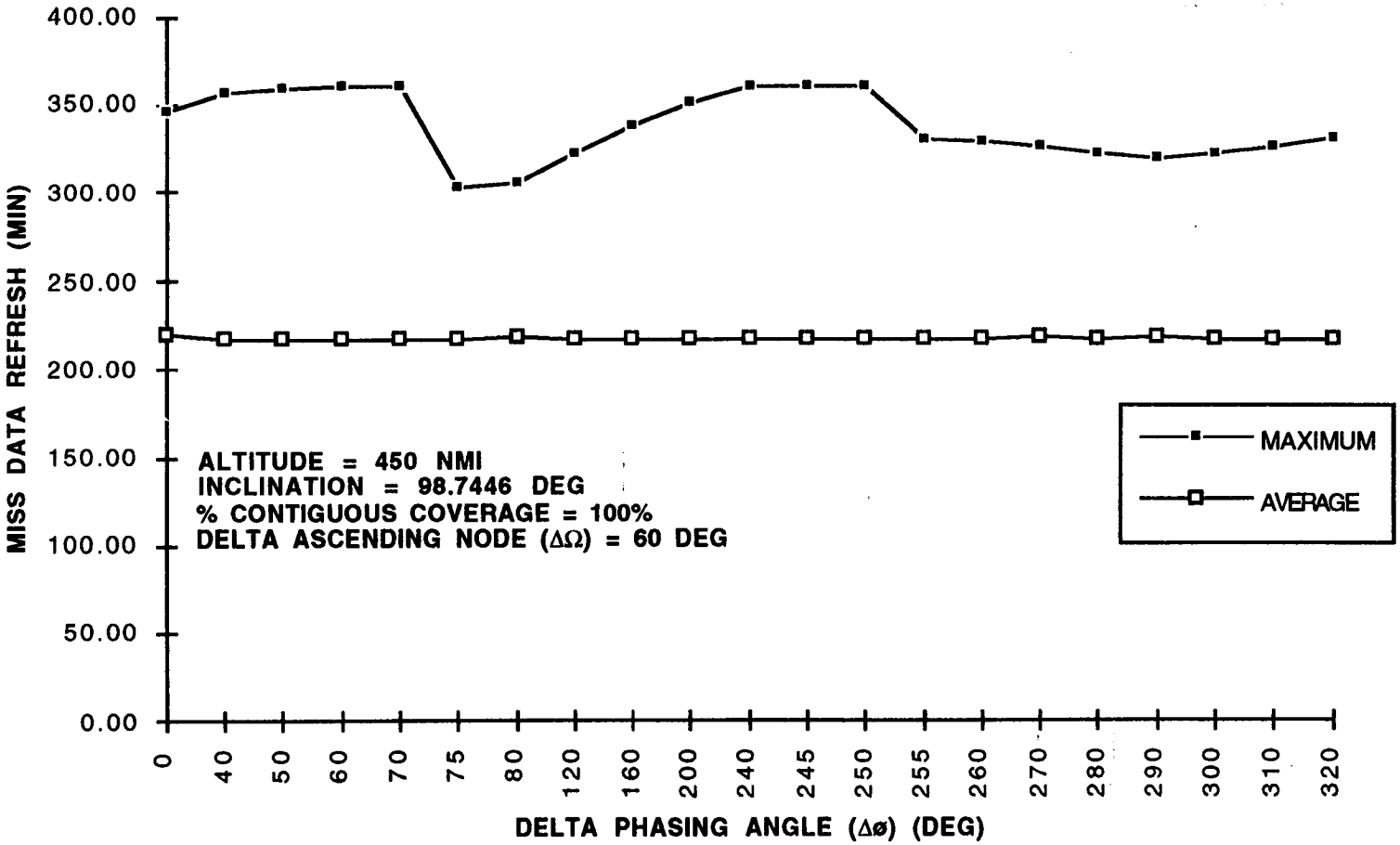
Delta Ascending Nodes ($\Delta\Omega$) = 60 Deg
(4 hrs between ascending nodes)

Delta Phasing Angle ($\Delta\phi$) =
Variable over range from 0-355 Deg

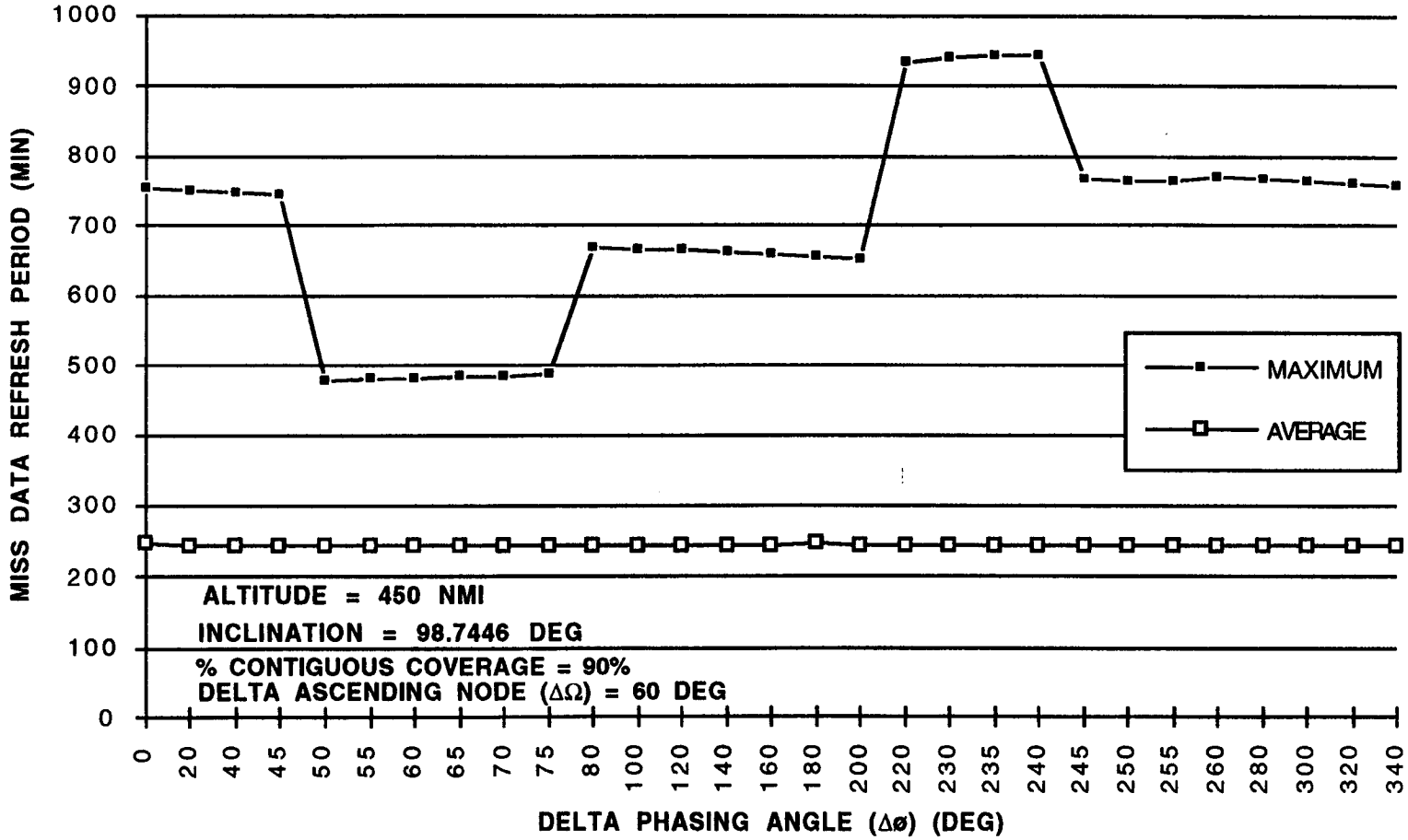


MISS DATA REFRESH OVER RANGE OF DELTA PHASING ANGLES - 100%

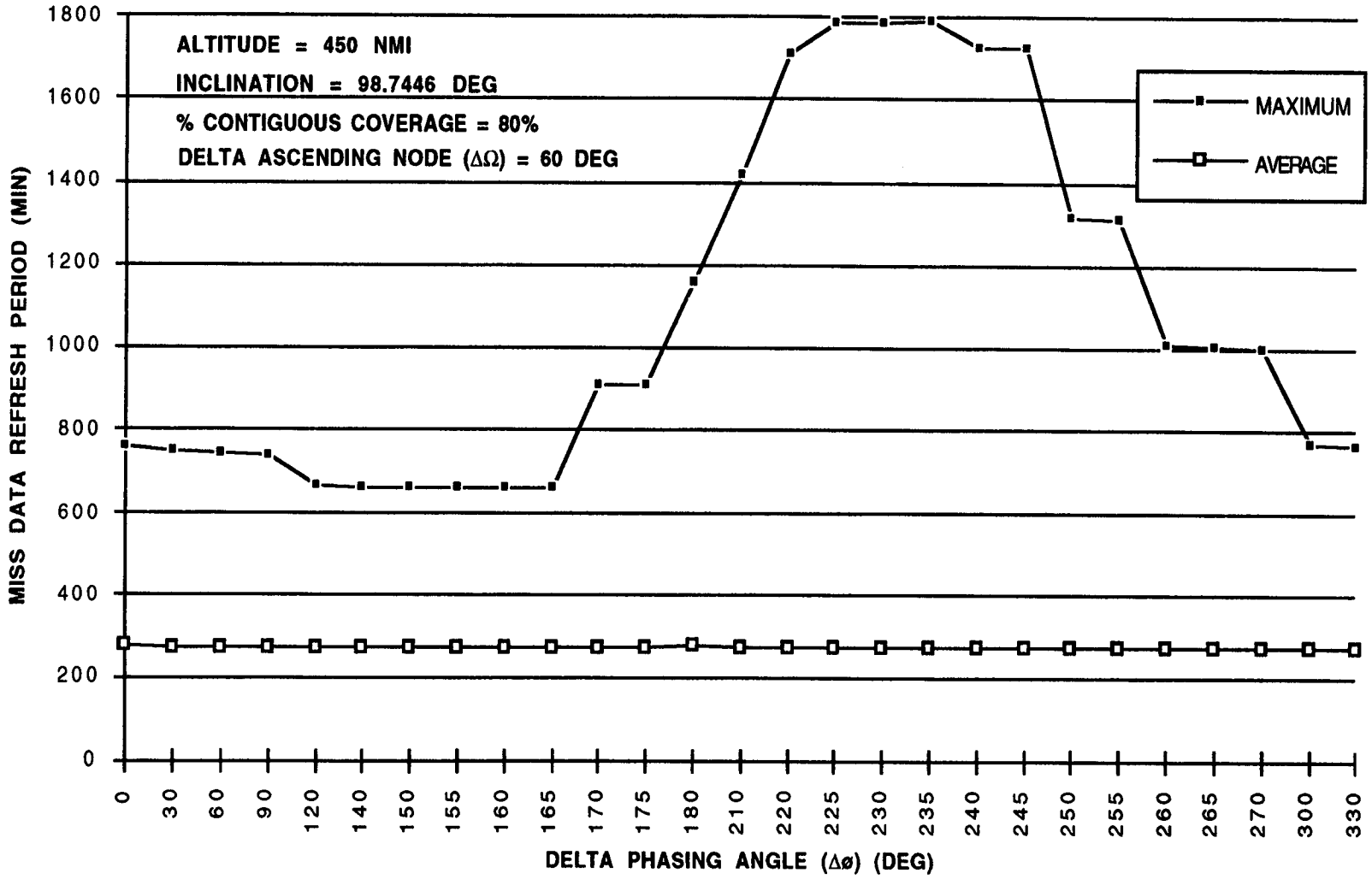
2 sats all through



MISS DATA REFRESH OVER RANGE OF DELTA PHASING ANGLES - 90%

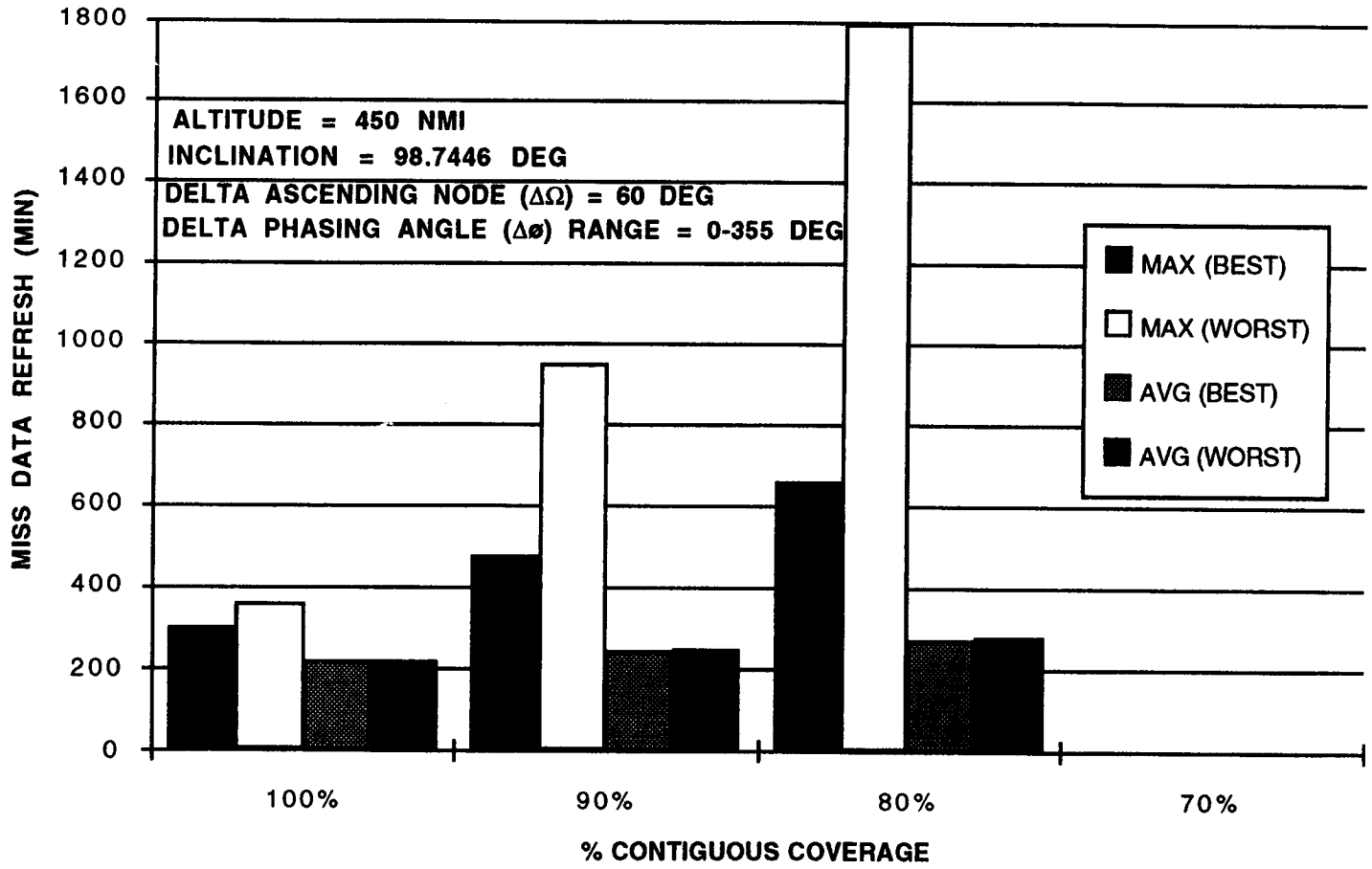


MISS DATA REFRESH OVER RANGE OF DELTA PHASING ANGLES - 80%



DMSP/POES CONVERGENCE STUDY

MISS DATA REFRESH OVER RANGE OF % CONTIGUOUS COVERAGE

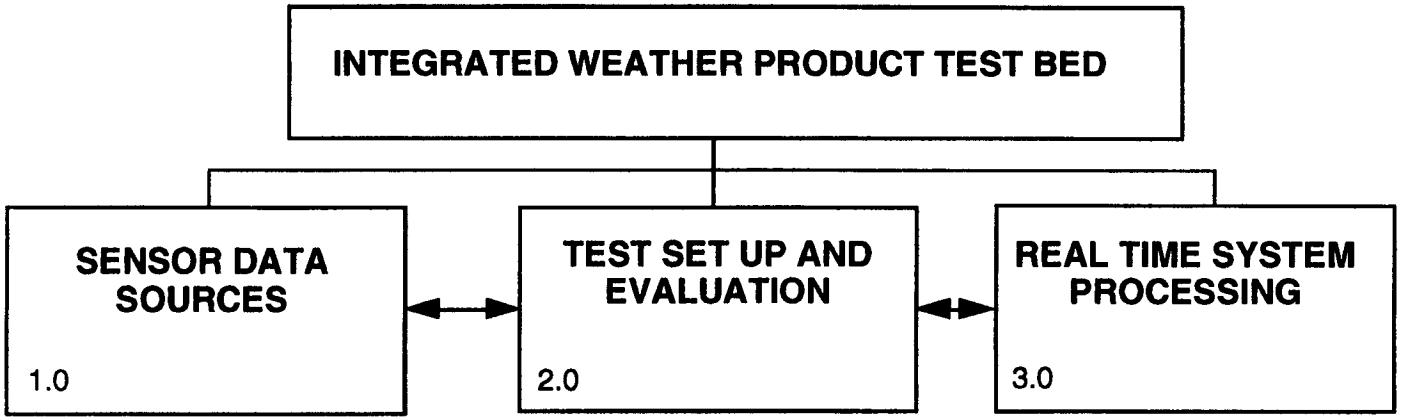


MISS PERFORMANCE PARAMETERS COMPARISON

% CONTIGUOUS COVERAGE	SWATH WIDTH (KM) AT 450 NMI	MISS EARTH INCIDENCE ANGLE (EIA) (DEG) *
100 %	2826.9	69.4
90 %	2544.2	66.2
80 %	2261.5	62.5
70 %	1978.8	58.2
60 %	1696.1	53.2

* USED SCAN ANGLE = 140 DEG

IWPTB HIERARCHY AND FEATURES



- ACQUIRE DATA FROM VARIOUS SOURCES
- FORMAT DATA TO SIMULATE BLOCK 6 SENSOR DATA
- DETERMINE GROUND TRUTH

- DEFINE TEST CONFIGURATION AND TEST EVENTS
- PERFORM TEST SET UP
- ANALYZE TEST RESULTS

- INPUT SIMULATED SENSOR DATA
- OBP EDU PRODUCES COMPRESSED SDRs
- FEP EMULATION PRODUCES 9 EDRs

LEGEND: ☐ = NON REAL TIME ☐ = REAL TIME

APPROACH TO SENSOR DATA SOURCES

- DEVELOP A GLOBALLY REPRESENTATIVE DATA BASE (INCLUDING STANDARD SCENES)
  - TROPICS, MID-LATITUDES, POLES
  - COVER FULL SPECTRAL AND SPATIAL RANGES
  - INCLUDE GROUND TRUTH SOURCES
- SOURCES INCLUDE: AVHRR, MODIS SIM, SSM /I /T1 /T2, TOPEX GPSR, RADIOSONDES, OCEAN BUOYS, FIELD OBSERVERS
- PREPARE DATA FOR USE: SCENE EXTRACTION, QUALITY CONTROL, GEOREFERENCING, IMAGE MOSIACKING, DATA STORAGE
- OMIS, MISS, AND SESS SCENE SIMULATION
- RAPID ACCESS TO DATA FOR ALL IWPTB USERS

APPROACH TO TEST SETUP AND EVALUATION

- DEVELOP AN EFFICIENT ENVIRONMENT TO GENERATE IWPTB TESTS
  - SIMPLIFIED SETUP PROCEDURES WITH DEFAULT VALUES
  - STORAGE AND RETRIEVAL OF TEST CONTROL FILES FOR TEST RERUNS
  - TEST EDIT AND MODIFICATION CAPABILITIES
- PROVIDE NECESSARY TEST EVALUATION TOOLS
  - EDR ALGORITHM SPECIFIC TOOLS
  - COMPARISON, PLOTTING, LISTING TOOLS
- SUPPORT DIVERSE USER NEEDS: ALGORITHM ANALYSIS, SYSTEM TRADE STUDIES, REQUIREMENTS VERIFICATION, SOFTWARE REGRESSION TESTING

APPROACH TO REAL-TIME SYSTEM PROCESSING

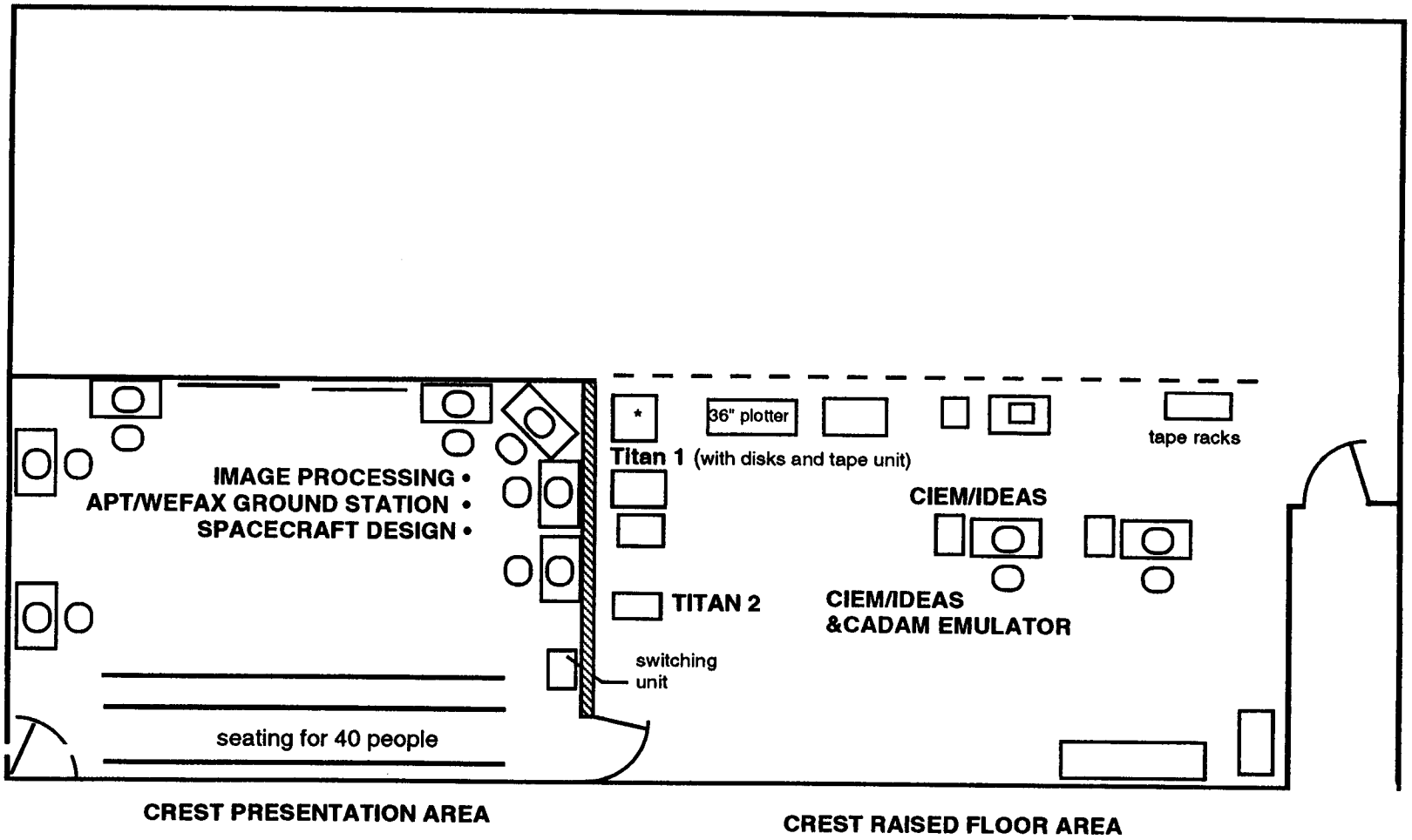
ON BOARD PROCESSING (OBP) ENGINEERING DEVELOPMENT UNIT (EDU)

- COMPRESS AND MERGE SENSOR DATA INTO THREE CONCURRENT DATA STREAMS
  - STORED MISSION DATA TO SOLID STATE MEMORY
  - 1 MBPS REAL-TIME STREAM TO TACTICAL SITES
  - 88 KBPS REAL-TIME STREAM TO SMALL TACTICAL TERMINALS
- READOUT STORED DATA AT COMMANDED TIMES

FRONT END PROCESSOR (FEP) EMULATOR

- SINGLE PROCESSING STRING CONFIGURED TO PROCESS ONE OF THREE DATA STREAMS
- RECORD ALL THREE DATA STREAMS
- STORE EDRs IN DATA BASE MANAGEMENT SYSTEM (DBMS)

CREST AND IWPTB AREAS IN BUILDING 104



SCALE 1/8" = 1 ft

10/19/93
TIM 2

SYSTEM RISK SUMMARY

- RISK ASSESSMENT PROCESS
- DMSP RISK ANALYSIS
  - CONVERGED RISKS
    - » PAYLOAD ACCOMMODATION
      - SIZE, WEIGHT, POWER
      - FOV'S, THERMAL
    - » DATA RATES END-TO-END

RISK MANAGEMENT PLAN

- ADDRESSES RISKS IN THE RISK REDUCTION PHASE WITH APPLICATION TO ENGINEERING, MANUFACTURING & DEVELOPMENT (EMD)
- PROVIDES IDENTIFICATION OF RISKS BY SUBSYSTEM
- PROVIDES METHOD FOR QUANTITATIVE ASSESSMENT AND A RANK ORDERING OF THE RISKS IN THE SYSTEM
- DESCRIBES RISK MITIGATION APPROACH FOR IDENTIFIED RISKS

RISK ASSESSMENT PREPARATION

- TEAM OF EXPERTS ASSEMBLED FOR EACH SUBSYSTEM
- POTENTIAL RISKS IDENTIFIED FOR EACH SUBSYSTEM
- EACH POTENTIAL RISK INITIALLY ASSESSED AS EITHER LOW, MEDIUM, OR HIGH
- FOR THOSE RISKS IDENTIFIED AS MEDIUM OR HIGHER, QUANTITATIVE RISK ASSESSMENT PERFORMED TO RANK RISKS
- QUANTITATIVE RISK ASSESSMENT CONSIDERS RISK IN EIGHT DIFFERENT RISK CATEGORIES

QUANTITATIVE RISK ASSESSMENT

ASSESSMENT BY RISK CATEGORIES ON 0 - 8 SCALE

- STATE OF TECHNOLOGY (SOT)
- DESIGN ENGINEERING DIFFICULTY (DED)
- MANUFACTURING PROCESS DIFFICULTY (MPD)
- PRODUCTION EQUIPMENT STATUS (EQI)
- MATERIAL RESOURCE STATUS (MAT)
- PERSONNEL RESOURCE STATUS (PER)
- TEST RESOURCE STATUS (TST)
- PERFORMANCE CONSEQUENCE (Cp) (0.1 - 0.9 SCALE)

QUANTITATIVE RISK ASSESSMENT (CONT)

- RISK SCORES COMBINED ADDITIVELY WHEN RISK FACTORS OPERATE INDEPENDENTLY
- RISK SCORES MULTIPLIED WHEN ONE RISK COMPOUNDED BY ANOTHER
- TOTAL SCORE NORMALIZED TO MAXIMUM VALUE POSSIBLE
- BOUNDARY VALUES BASED ON MINIMUM EXIT CRITERIA DEFINED IN DOD STDS AND COST AND SCHEDULE IMPACT

CONVERGED SYSTEM MEDIUM RISKS - SPACE SEGMENT

SPACECRAFT

- DATA COMPRESSION REQUIREMENTS FOR TRANSMISSION OF DATA TO GROUND (ON ALL CONFIGURATIONS BUT I2) SIGNIFICANTLY HIGHER THAN DMSP BASELINE
- SIGNIFICANT INCREASE IN ON-BOARD PROCESSING AND SOLID STATE MEMORY REQUIREMENTS OVER BLOCK 6 SYSTEM
- HIGHER POWER AND WIDER BANDWIDTH SYSTEM (AFFECTING COST, WEIGHT, AND POWER) REQUIRED TO DOWNLINK DATA IF DATA COMPRESSION NOT FEASIBLE
- G4 AND I4 CONFIGURATIONS REQUIRE CONSIDERABLE DESIGN EFFORTS TO MEET SPACE LIMITATIONS
- SIGNIFICANT COST INCREASE REQUIRED TO LAUNCH B3 AND H3 CONFIGURATIONS ON ATLAS BOOSTER

CONVERGED SYSTEM MEDIUM RISKS - C3 SEGMENT

DATA ROUTING AND RETRIEVAL

- CURRENT AFSCN SYSTEM MAY BE INADEQUATE FOR DATA DOWNLINK IF DATA COMPRESSION REQUIREMENTS CAN NOT BE MET
- ALTERNATIVE USE OF CDA SITES FOR DOWNLINK OF DATA REQUIRES WIDER BANDWIDTH THAN IS CURRENTLY AVAILABLE

SOC

- TRANSITION FROM 5D-3 TO BLOCK 6
- TRANSITION FROM NOAA OPERATIONS TO CONVERGED SYSTEM
- DUAL OPERATIONS OF SPACECRAFT

CONVERGED SYSTEM MEDIUM RISKS - USER SEGMENT

ALGORITHM DEVELOPMENT

- DEVELOPMENT OF ALGORITHMS FOR THE MEASUREMENT OF VISIBILITY, NEUTRAL ATMOSPHERIC PARAMETERS, VERTICAL TEMPERATURE AND VERTICAL MOISTURE PROFILES
- GROUND TRUTHING OF SESS ALGORITHMS WITH TEST DATA

CENTRAL SITES

- MEETING TIMELINESS REQUIREMENTS DUE TO INCREASE IN QUANTITY OF DATA TO BE PROCESSED
- LARGE SOFTWARE DEVELOPMENT EFFORT

CONFIGURATION RISK SUMMARY

RISK AREA \ CONFIG	A3	B3	C3	G3	G4	H3	I2	I4
VOLUME	L	H	M	M	H	H	L	H
WEIGHT	L	L	L	L	L	L	L	L
POWER	L	M	L	L	L	M	L	L
FOV	L	H	M	M	H	H	L	H
DATA RATE	M	H	M	M	M	H	M	M
SOL ARRAY SIZE	L	M	L	L	L	M	L	L
S/C SUMMARY	M	H	M	M	H	H	M	H

L = LOW M = MEDIUM H = HIGH

BRIEFING SUMMARY

- O ALL "OPERATIONAL" INSTRUMENTS FIT ON THE [redacted] BUS, ON THE DELTA II.
- O DETAILED THERMAL, FIELDS OF VIEW, ATTITUDE CONTROL, STABILITY, AND OBP STUDIES LOWER RISK
- O LIFE CYCLE COST SAVINGS OCCUR WITH A SINGLE SYSTEM DEVELOPMENT, COMMON INSTRUMENTS, AND SINGLE OPERATIONS.
- O NEXT PHASE--EMD DOWNSELECT--SHOULD OCCUR IN EARLY 1997