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Volume II

AVIONICS PROCESSOR-CONTROLLER CONFIGURATION STUDY

APPENDIX A-VOLUME II

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TECHNICAL REPORT AFAL-73-TR-203 VOL. II

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NOTICE

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FOREWORD

This Final Engineering Report was prepared by the Electronics Group of Rockwell International, Anaheim, California. The work was accomplished under USAF Project 6090 entitled "Avionics Data Handling Technology", Task 01 entitled "Avionics Information Processing" and contract No. F33615-72-C-1973 entitled "Avionics Processor-Controller Configuration Study." The work was administered under the direction of Mr. J. E. Camp, Air Force Avionics Laboratory, AFAL/AAM, Wright-Patterson AFB, Ohio.

This report covers work conducted from 1 July 1972 to 30 June 1973 and was submitted by the author 30 April 1973.

This technical report has been reviewed and is approved for publication.

COZIER S. KLINE
Colonel, USAF
Chief
System Avionics Division

ABSTRACT

An advanced strategic bomber avionics system was used as the baseline avionics system to provide the computational requirements for the avionics processor controller study. This volume contains the detailed processing requirements of the major computational functions. This report is also being published as Autonetics internal report C72-812/201.

CONTENTS

ILLUSTRATIONS

TABLES

1. INTRODUCTION

The ASB* avionics system was used as the baseline avionics system to provide the computational requirements for the avionics processor - controller study. Volume 1, the main technical report, contained a summary of the requirements analysis in Section 2. In Section 2 of Volume 1 the ASB avionics system was defined and a summary of the processing throughput, storage, and I/O requirements was given.

The overall processing tasks were grouped into nine major processing functions:

1. Navigation
2. Steering
3. Target/Checkpoint Acquisition
4. Weapon Delivery
5. Penetration Aids
6. Terrain Following/Avoidance
7. Mission Data Management
8. Mission and Traffic Control
9. Central Integrated Test Subsystem

The detailed processing requirements and description of each of these functions will be given in this report.

*ASB: Advanced Strategic Bomber

2. NAVIGATION FUNCTION

2.1 GENERAL DESCRIPTION

The Navigation function provides knowledge of air vehicle present position, velocity, attitude, and altitude. This information is used for front and rear cockpit display and by other functions, e.g., Target/Checkpoint Acquisition, Weapon Delivery, Penetration Aids, etc. In addition, alignment of the Short Range Ballistic Missile (SRAM) inertial guidance systems is provided using raw data from the missiles and reference data from the navigation sensors. Control of two identical Inertial Measurement Units (IMU's) is also performed within the Navigation function.

All sensor/missile/fixtaking data are mixed using Kalman filtering techniques. This results in optimum navigation and missile alignments using all available navigation sensor sources. Present position and velocity fixtaking corrections are applied upon occurrance from the Target/Checkpoint Acquisition function.

The primary navigation sensors utilized are the two IMU's. Augmentation of the inertially derived information is provided by mixing sensor measured data from the Doppler Radar Set (DRS), Central Air Data Computer (CADC), and Radar Altimeter Set (RAS). While primary attitude is obtained from the IMU's, backup attitude is available from the Gyro Stabilization Subsystem (GSS), which is part of the Air Vehicle Electronics (Non-Avionics).

Control of the Navigation function is selected from the Navigation Control Panel (NCP). Navigation information is displayed on two identical Navigation Display Panels (NDP's). One NDP is located in the front cockpit while the other is located in the rear cockpit. A chronometer Unit (CU) is connected to each NDP.

Figure A-1 shows the major interconnecting hardware elements. A function block diagram is shown in Figure A-2. Subfunction interface signals are listed in Table A-1. Table A-2 details the modes and subfunctions. The memory and throughput processing requirements are delineated in Tables A-3 and A-4. The throughput requirements are in operations/sec which represent a mix of operation (instruction) types as was explained in Section 2.2 of Volume 1. The storage requirements are in words, independent of word length, as explained in Section 2.2 of Volume 1 a multiplying factor of 1.3 will convert these into equivalent 16 bit words. Table A-4 breaks each of the tasks that comprise the navigation function down into subtasks. Table A-4 shows the amount of instructions and data required for each task, the throughput in operations/sec, and whether the task contributes to the worst case throughput requirements (all but 1.14 and 1.15 contribute). This table also identifies the prerequisite tasks for each task (e.g., task 1.3 is a prerequisite to 1.4, 1.4 is a prerequisite to 1.7, etc.).

2.2 ASSUMPTIONS

1. Two identical IMU's were incorporated in the avionics configuration for this study. This was based on the Air Force decision to replace the Stellar Inertial Navigator (SIN) and Auxiliary Inertial Navigator (AIN) with the Litton LN-15S Inertial Navigator.

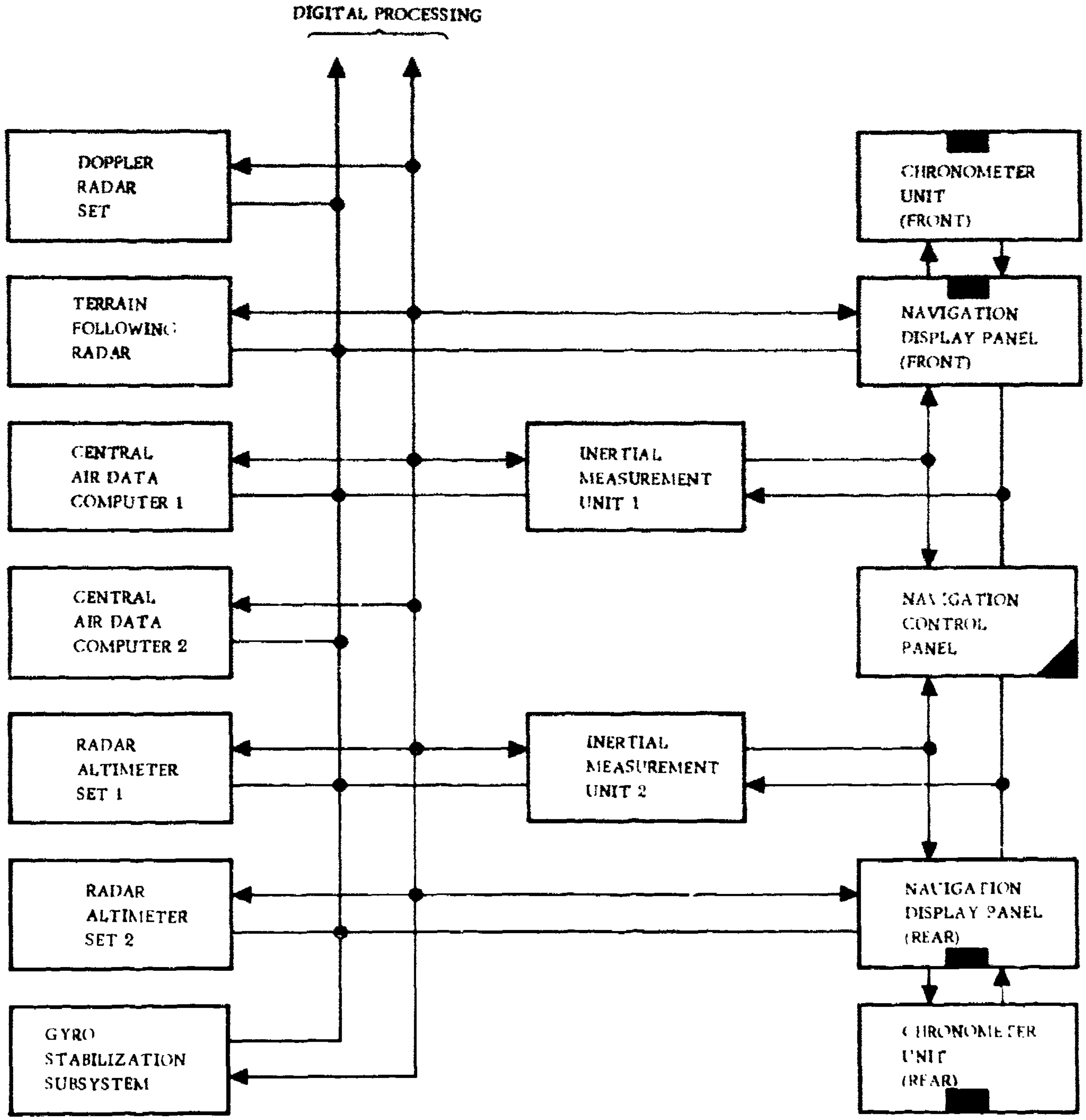

Figure A-1. Navigation Function Equipment Interface

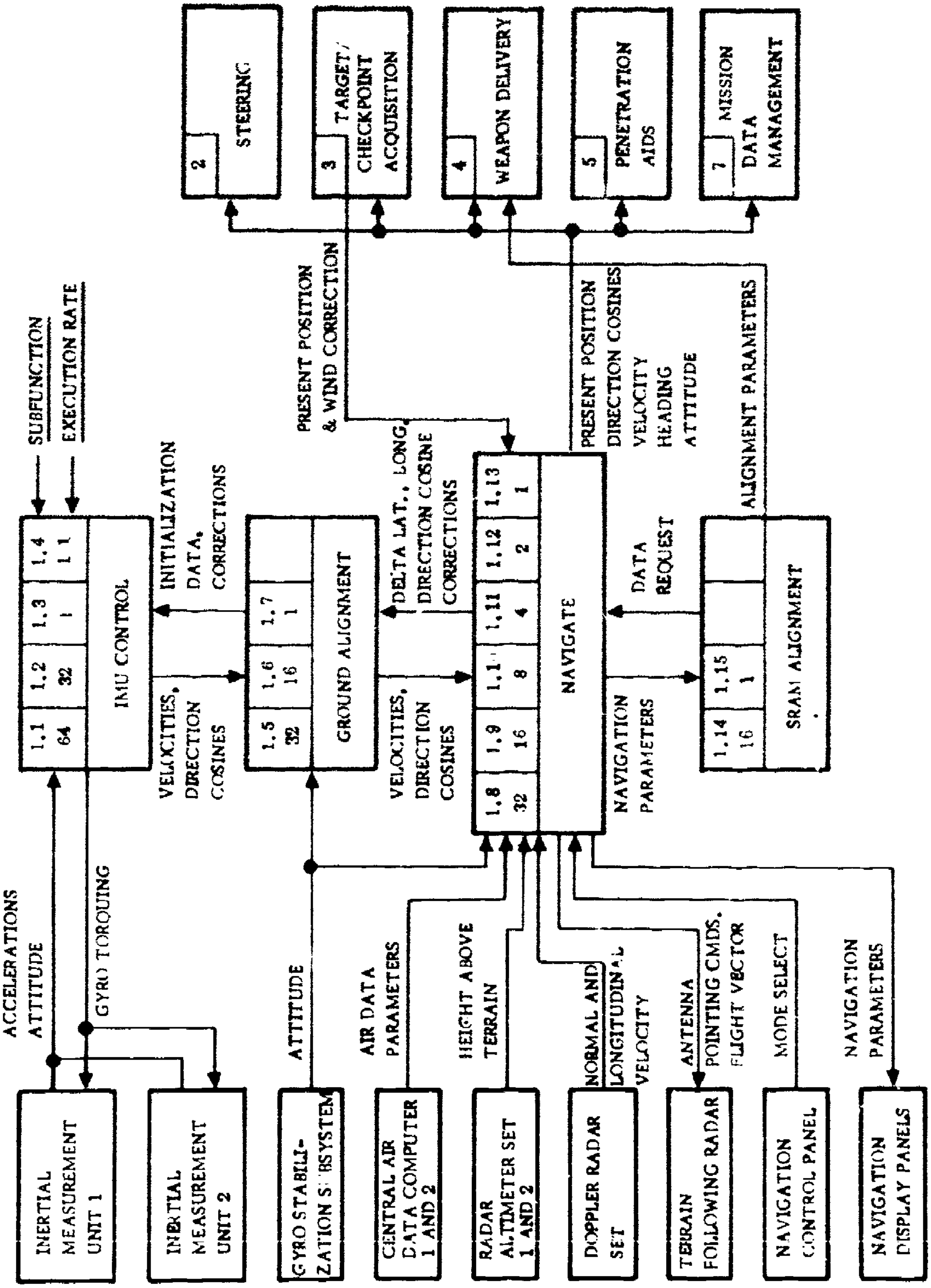

Figure A-2. Navigation Function Block Diagram

Table A-1. Navigation Intrafunction Signals

Signal Source Task \ Signal Destination Task	1.1 IMU Control-Fast	1.2 IMU Control-Mid	1.3 IMU Control-Slow	1.4 IMU Control-Filter	1.5 Ground Align-Fast	1.6 Ground Align-Mid	1.7 Ground Align-Slow	1.8 Navigate-Fast	1.9 Navigate - 16/Sec	1.10 Navigate - 8/Sec	1.11 Navigate - 4/Sec	1.12 Navigate-Slow	1.13 Navigate-Filter	1.14 SRAM Align-Fast	1.15 SRAM Align-Slow
1.1 IMU Control-Fast				8	12			12							
1.2 IMU Control-Mid				8		18			18						
1.3 IMU Control-Slow				6			10			10					
1.4 IMU Control-Filter	8	8	6												
1.5 Ground Align-Fast								72							
1.6 Ground Align-Mid									36						
1.7 Ground Align-Slow												10			
1.8 Navigate-Fast		2							36	36	36	36	72	48	48
1.9 Navigate - 16/Sec								36		36	36	36	36	36	36
1.10 Navigate - 8/Sec		4						12	12		12	12	12	12	12
1.11 Navigate - 4/Sec		13						10	10	10		10	10	10	10
1.12 Navigate-Slow								10	10	10	10		10	10	10
1.13 Navigate-Filter								72	36	12	10	10			
1.14 SRAM Align-Fast															
1.15 SRAM Align-Slow															

Table A-2. Navigation Function Modes and Subfunctions

Subfunctions (Tasks) \ Modes		Ground Alignment	Navigate	SRAM Alignment
1.1	IMU Control-Fast	X	X	X
1.2	IMU Control-Mid	X	X	X
1.3	IMU Control-Slow	X	X	X
1.4	IMU Control-Filter	X	X	X
1.5	Ground Align-Fast	X		
1.6	Ground Align-Mid	X		
1.7	Ground Align-Slow	X		
1.8	Navigate-Fast	X	X	X
1.9	Navigate - 16/Sec	X	X	X
1.10	Navigate - 8/Sec	X	X	X
1.11	Navigate - 4/Sec	X	X	X
1.12	Navigate-Slow	X	X	X
1.13	Navigate-Filter	X	X	X
1.14	SRAM Align-Fast			X
1.15	SRAM Align-Slow			X

Table A-3. Navigation Function Processing Requirements Summary

Task	Title	(IT/Sec)	Memory (Words)	Time (KOPS/Sec)
1.1	IMU Control - Fast	64	218	18.02
1.2	IMU Control - Mid	32	653	37.65
1.3	IMU Control - Slow	1	394	0.46
1.4	IMU Control - Filter	1	217	0.58
1.5	Ground Alignment - Fast	32	76	2.87
1.6	Ground Alignment - Mid	16	696	13.50
1.7	Ground Alignment - Slow	1	384	0.75
1.8	Navigate - Fast	32	882	32.90
1.9	Navigate - 16/Sec	16	240	13.76
1.10	Navigate - 8/Sec	8	180	2.88
1.11	Navigate - 4/Sec	4	500	1.44
1.12	Navigate - Slow	2	355	0.54
1.13	Navigate - Filter	1/8	7632	0.65
1.14	SRAM Alignment - Fast	16	550	2.50
1.15	SRAM Alignment - Slow	1	240	0.18
			13,217	126.00

Table A-4. Navigation Function Detail Processing Requirements (Sheet 1 of 6)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
1.1	IMU Control - Fast							
	1. IMU Switching 2. Accelerometer Sampling 3. Gyro Torquing							
	Task Total	9.1	176	42	281	64	18.62	*
1.2	1. IMU Switching 2. Incremental Platform Velocities 3. Gravity 4. Coriolis 5. Vertical Velocity 6. Total Platform Velocities 7. Earth Radius 8. Platform Relative Rates 9. Spatial Rates 10. Platform Control Rates 11. Gyro Control Rates 12. Gyro Torque Angle Residual 13. Direction Cosines 14. Platform Azimuth 15. Acceleration Sensitive Drifts 16. Platform Controller Extrapolation 17. Platform Slew 18. Platform Stabilization							
	Task Total	9.1	473	180	1176	32	37.65	*
1.3	IMU Control - Slow							
	1. IMU Switching 2. Level VM Bias Compensation 3. Platform Wander Angle 4. Reset Control Vector							

Table A-4. Navigation Function Detail Processing Requirements (Sheet 2 of 6)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
1.3 (Cont)	IMU Control - Slow							
	5. Reset Control Rate							
	6. Thermal Drift Update							
	7. Platform Controller Reset							
	8. Controller Reset Application							
	9. Power Up/Transient Initialization							
	10. Filter Initialization							
	11. Platform Constants Update							
	Task Total	9.1	288	106	460	1	.46	*
1.4	IMU Control - Filter							
	1. IMU Switching							
	2. Nav Velocity Corrections							
	3. Direction Cosines Correction							
	4. Longitude Correction							
	5. Tilt Correction							
	6. Navigation Reset							
	Task Total	1.3	102	115	583	1	.58	*
1.5	Ground Alignment - Fast							
	1. IMU Switching							
	2. Platform Velocities							
	3. Vertical Velocity							
	Task Total	1.2	56	20	89	32	2.87	*
1.6	Ground Alignment - Mid							
	1. IMU Switching							
	2. Initialization							
	Task Total	9.1	490	206	844	16	13.50	*

Table A-4. Navigation Function Detail Processing Requirements (Sheet 3 of 6)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
1.7	Ground Alignment - Slow							
	1. IMU Switching							
	2. Velocity Corrections							
	3. Alpha Angle							
	4. Alignment Filter							
	Task Total	1.4	344	40	750	1	.75	*
1.8	Navigate - Fast							
	1. Mode Selection and Status							
	2. Air Data - Body Velocities							
	3. Air Data - Platform Velocities							
	4. DRS - Body Velocities							
	5. DRS - Platform Velocities							
	6. DRS - Overwater Logic							
	7. Inertial/DR Processing							
	8. IMU Switching							
	Task Total	1.5	661	221	1028	32	32.90	*
1.9	Navigate - 16/Sec							
	1. Ground Track							
	2. True Heading							
	3. Ground Track Azimuth							
	4. Flight Path Angle							
	5. Drift							
	6. Misc. Parameters							
	7. Update Direction Cosines							
	Task Total	1.6	200	40	860	16	13.76	*

Table A-4. Navigation Function Detail Processing Requirements (Sheet 4 of 6)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
1.10	Navigate - 8/Sec							
	1. Compute Air Data Parameters 2. Compute Wind Speed Comps. 3. True Airspeeds Components 4. Filter Winds 5. Misc. Parameters							
	Task Total	9.1	150	30	360	8	2.88	*
1.11	Navigate - 4/Sec							
	1. Present Position Parameters 2. Incremental Angular Rates 3. Direction Cosine Update 4. Winds							
	Task Total	9.1	450	50	360	4	1.44	*
1.12	Navigate - Slow							
	1. Mode Determination 2. DRS Temp Correction 3. Nav Filter Initialization							
	Task Total	9.1	335	20	268	2	.54	*
1.13	Navigate - Filter							
	1. IMU 1 Control Vector 2. IMU 2 Control Vector 3. Nav Covariance Init. (Q) 4. MSL[(1)] Covariance Init. (Q) 5. Nav Resets (X_c) 6. MSL Resets (X_c) 7. IMU 1 Dir. Cosine Update 8. IMU 2 Dir. Cosine Update 9. Nav Inertial Rate and H. Setup							

Table A-4. Navigation Function Detail Processing Requirements (Sheet 5 of 6)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
1.13 (Cont)	Navigate - Filter							
	10. Missile Inertial Rate and H. Setup							
	11. Transition Subroutine							
	12. Nav Extrapolation (X Q)							
	13. Missile Extrapolation (X Q)							
	14. Setup C, M, and Y							
	15. Pre-Est F', Y', and D' (Nav)							
	16. Pre-Est F', Y', and D' (Missile)							
	17. Setup Y (Missile)							
	18. Setup Y, D, and Diag D' (Nav)							
	19. Setup X, D, and Diag D' (Missile)							
	20. Reset Q and Est X (Nav)							
	21. Reset Q and Est X (Missile)							
	22. Symmetrize Q and Rescale (Nav)							
	23. Symmetrize Q and Rescale (Missile)							
	24. Variable Storage (Nav)							
	a. IMU 1 Cov (18 x 18)							
	b. IMU 2 Cov (18 x 18)							
	c. IMU 1 State Vector (18 x 1)							
	d. IMU 2 State Vector (18 x 1)							
	e. IMU 1 Control Vector (18 x 1)							
	f. IMU 2 Control Vector (18 x 1)							
	g. Filter Coef. (18 x 2)							
	h. Meas. Matrix (18 x 2)							
	i. IMU 1 Observables (2 x 1)							
	j. IMU 2 Observables (2 x 1)							
	k. D Matrix (2 x 2)							

Table A-4. Navigation Function Detail Processing Requirements (Sheet 6 of 6)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
1.13 (Cont)	Navigate - Filter							
	25. Variable Storage (Missile)							
	a. Startup Cov. (10 x 10) b. Steady State Cov. (10 x 10) c. State Vector (32 x 10) d. Control Vector (32 x 10) e. Filter Coef. (2 x 10) f. Measurement Matrix (2 x 10) g. Observables (Y) (32 x 2) h. D Matrix (2 x 2)							
	Task Total	-	5770	1862	5176	1/8	0.65	*
1.14	SRAM Align - Fast							
	1. Logic 2. Tilt/Velocity Correction 3. Align Data Transfer							
	Task Total	1.9	195	355	156	16	2.50	
1.15	SRAM Align - Slow							
	1. SRAM Selection 2. Initializatization							
	Task Total	1.7	225	15	180	1	0.18	
	Function Total		9915	3302			126.00	

2. The digital processing requirements were pulled out of the inertial navigator to create two inertial measurement units, i.e., no autonomous navigation capability. Should an autonomous navigation requirement be imposed on the inertial subsystems, additional processing requirements will then require definition to provide this dedicated capability. In addition to the segmented platform control processing; additional executive, data entry/display, self-test, and other support functions will require definition as will the stand-alone ground alignment navigate functions and the central navigation to inertial navigator intercommunication requirements.

3. The Terrain Following Radar (TFR) digital processing requirements are included in the navigation function due to the minimal requirements of the existing unit. If a separate advanced digital TFR is included in the ASB system configuration, the processing requirements would be defined separately. Should the TFR function be incorporated in an advanced multi-function radar for the ASB such as the Electronically Agile Radar (EAR), the terrain following/avoidance processing requirements will probably be included in a Radar Control subfunction within the Target/Checkpoint Acquisition function.

4. No digital processing is required to support the Chronometer Unit.

5. Only one set of IMU control and one set of Ground Alignment tasks are required since the IMU's are identical. Duplicate computation is assumed either by subroutining or boosting data pointers and then recomputing.

3. STEERING FUNCTION

3.1 GENERAL DESCRIPTION

The Steering function provides both pitch and lateral steering signals to the Automatic Flight Control Subsystem (AFCS) for automatic control of the air vehicle in accordance with the selected steering mode. It also provides similar pitch and lateral steering signals, along with course deviation (and glideslope deviation signals when appropriate) to the Flight Director Computer (FDC) for display on the Vertical Situation Display (VSD) and Horizontal Situation Indicator (HSI).

Figure A-3 shows the major interconnecting hardware elements. A function block diagram is shown in Figure A-4. Subfunction interface signals are listed in Table A-5. Table A-6 details the modes and subfunctions. The memory and throughput requirements are delineated in Tables A-7 and A-8.

3.2 ASSUMPTIONS

1. Due to safety of flight considerations, two identical and independent steering functions are provided for redundancy.

2. Channel selection of which steering function to use, either 1, 2, or 1 and 2 will be made under pilot control on the Steering Control Panel. Cross channel driving signals to the AFCS, HSI, and VSD units are possible between FDC's under pilot selection.

3. Due to safety of flight considerations and specialized function aspects of the FDC and AFSC, the directly associated computation requirements were left dedicated within these subsystems.

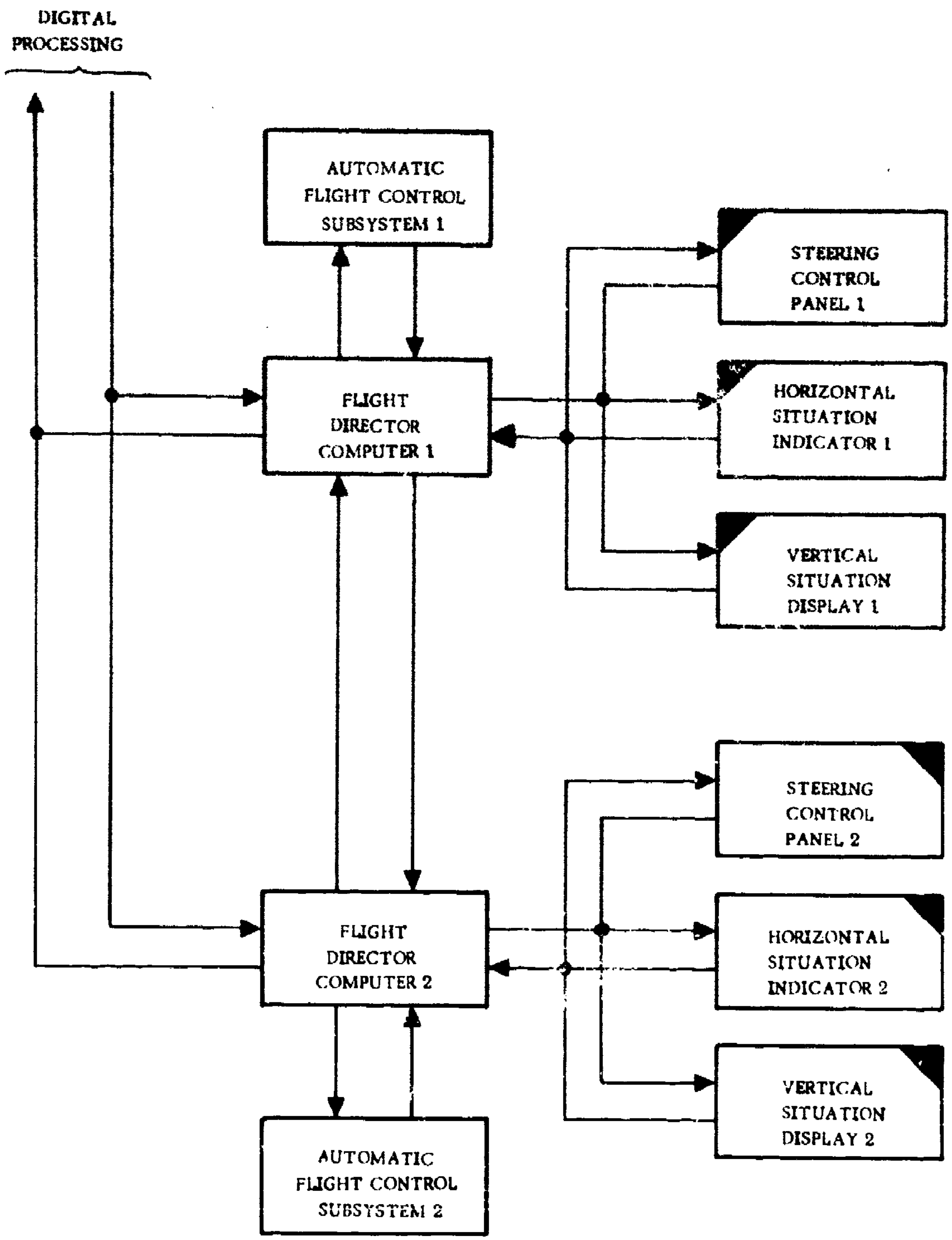

Figure A-3. Steering Function Interfacing Hardware

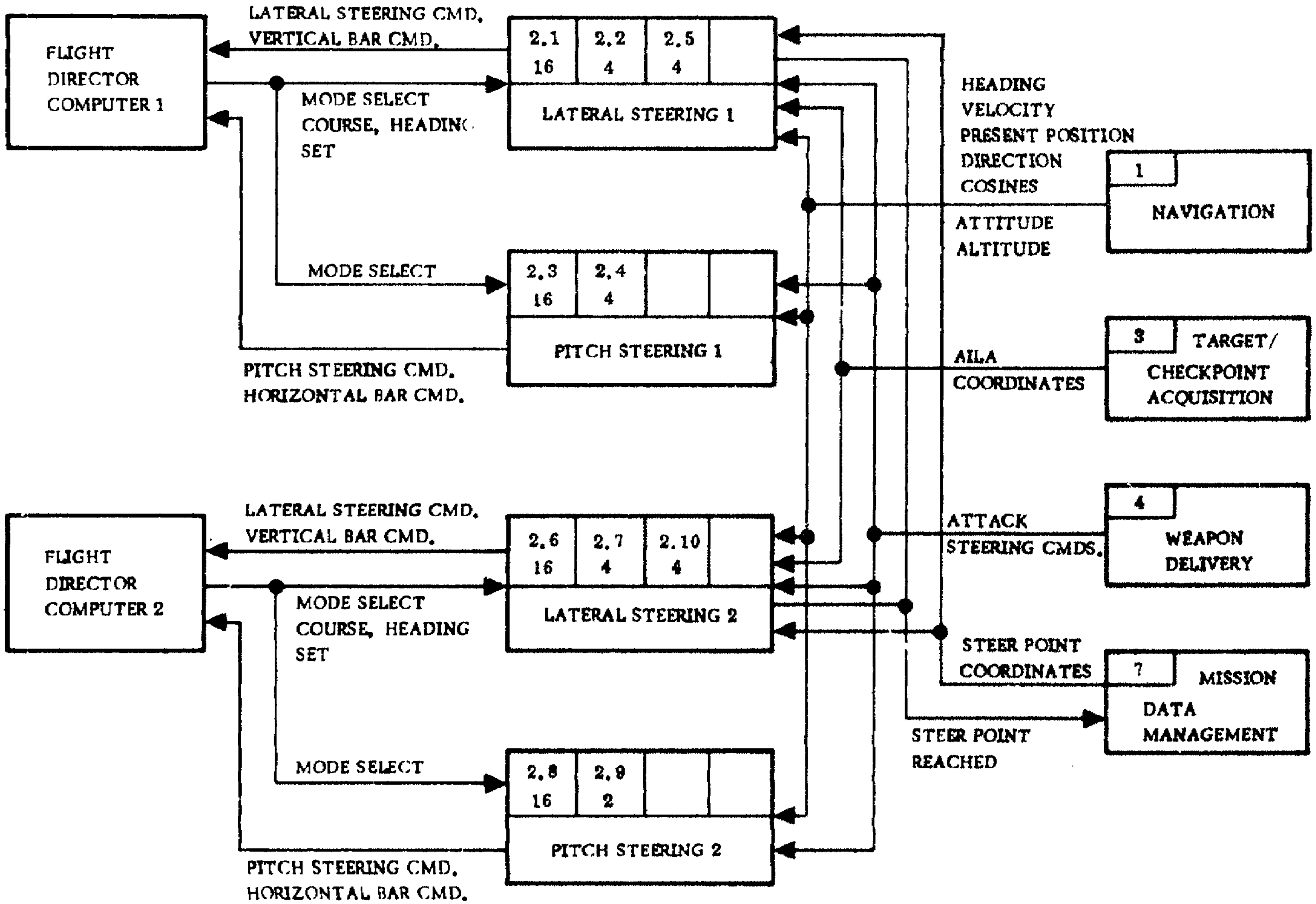

Figure A-4. Steering Function Block Diagram

Figure A-5. Steering Intrafunction Signals

Signal Source Task \ Signal Destination Task		Lateral Steering 1 - Fast (2.1)	Lateral Steering 1 - Slow (2.2)	Pitch Steering 1 - Fast (2.3)	Pitch Steering 1 - Slow (2.4)	Range Subroutine 1 (2.5)	Lateral Steering 2 - Fast (2.6)	Lateral Steering 2 - Slow (2.7)	Pitch Steering 2 - Fast (2.8)	Pitch Steering 2 - Slow (2.9)	Range Subroutine 2 (2.10)
2.1	Lateral Steering 1 - Fast		6								
2.2	Lateral Steering 1 - Slow	2				6					
2.3	Pitch Steering 1 - Fast				4						
2.4	Pitch Steering 1 - Slow			2							
2.5	Range Subroutines 1		8								
2.6	Lateral Steering 2 - Fast							6			
2.7	Lateral Steering 2 - Slow						2				6
2.8	Pitch Steering 2 - Fast									4	
2.9	Pitch Steering 2 - Slow								2		
2.10	Range Subroutine 2							8			

Table A-6. Steering Function Modes and Subfunctions

Subfunction's (Tasks) \ Modes		AILA	Great Circle	Course Line	Tanker Rendezvous	Course Select	Constant Ground Track	Attack Steering
2.1	Lateral Steering 1 - Fast	X	X	X	X	X	X	X
2.2	Lateral Steering 1 - Slow	X	X	X	X	X	X	X
2.3	Pitch Steering 1 - Fast	X			X			
2.4	Pitch Steering 1 - Slow	X			X			
2.5	Range Subroutine - 1	X	X		X			
2.6	Lateral Steering 2 - Fast	X	X	X	X	X	X	X
2.7	Lateral Steering 2 - Slow	X	X	X	X	X	X	X
2.8	Pitch Steering 2 - Fast	X			X			
2.9	Pitch Steering 2 - Slow	X			X			
2.10	Range Subroutine 2	X	X		X			

Table A-7. Steering Function Processing Requirements Summary

Task	Title	(IT/Sec)	Memory (Words)	Time (KOPS/Sec)
2.1	Lateral Steering 1 - Fast	16	60	0.6
2.2	Lateral Steering 1 - Slow	4	732	6.0
2.3	Pitch Steering 1 - Fast	16	432	0.8
2.4	Pitch Steering 1 - Slow	4	56	0.2
2.5	Range Subroutine 1	-	170	-
2.6	Lateral Steering 2 - Fast	16	60	0.6
2.7	Lateral Steering 2 - Slow	4	732	6.0
2.8	Pitch Steering 2 - Fast	16	432	0.8
2.9	Pitch Steering 2 - Slow	4	56	0.2
2.10	Range Subroutine	-	170	-
	Total		2900	15.2

Table A-8. Steering Function Detail Processing Requirements (Sheet 1 of 2)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
2.1	Laterial Steering 1 - Fast							
	1. Horizontal Steering							
	Task Total	1.9	49	11	40	16	.60	*
2.2	Lateral Steering 1 - Slow							
	1. Mode Change							
	2. Nav Steering Data							
	3. Course Line							
	4. Great Circle							
	5. AILA							
	6. Tanker Rendezvous							
	7. Nav Lateral Steering							
	8. Misc. Logic and Scaling							
	Task Total	1.11	624	108	1505	4	6.00	*
2.3	Pitch Steering 1 - Fast							
	1. Pitch Steering							
	2. Pitch Submode							
	Task Total	2.1	360	72	48	16	0.80	*
2.4	Pitch Steering 1 - Slow							
	1. Tanker Rendezvous							
	Task Total	2.2	50	6	40	4	0.20	*
2.5	Range Subroutine - 1							
	Task Total	-	135	35	470	-	-	

Table A-8. Steering Function Detail Processing Requirements (Sheet 2 of 2)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
2.6	Lateral Steering 2 - Fast							
	Same as 2.1							
	Task Total	1.9	49	11	40	16	0.60	*
2.7	Lateral Steering 2 - Slow							
	Same as 2.2							
	Task Total	1.11	624	108	1505	4	6.00	*
2.8	Pitch Steering 2 - Fast							
	Same as 2.3							
	Task Total	2.1	360	72	48	16	0.80	*
2.9	Pitch Steering 2 - Slow							
	Same as 2.4							
	Task Total	2.2	50	6	40	4	0.20	*
2.10	Range Subroutine							
	Task Total	-	135	35	470	-	-	
	Functional Total		2436	464			15.20	

4. TARGET/CHECKPOINT ACQUISITION

4.1 GENERAL DESCRIPTION

The Target/Checkpoint Acquisition (TCA) function provides the capability to update present position, determine reconnaissance point locations, compute range to target for weapon delivery, and control associated radar and electro-visual sensors (EVCS). The TCA function operates as part of the Offensive System under control of the Offensive System Operator (OSO). The sensors controlled by the TCA function include the Forward Looking Radar (FLR), the Low Light Level Television (LLLTV), and the Forward Looking Infrared (FLIR). Video recording of the sensor acquired information is also under automatic control of the TCA function.

Figure A-5 shows the major interconnecting hardware elements. A function block diagram is shown in Figure A-6. Subfunction interface signals are listed in Table A-9. Table A-10 details the modes and subfunctions. The memory and throughput requirements are delineated in Tables A-11 and A-12.

4.2 ASSUMPTIONS

1. No air-to-air target acquisition modes exist.
2. Minimal radar control processing is required, i.e., commanding of slant range and azimuth commands for radar pointing and display cursor strobing.
3. Present position updating is performed using radar, LLLTV, or FLIR.
4. A recon point determination capability exists using the radar, LLLTV, or FLIR.
5. Should the Electronically Agile Radar (EAR) be incorporated in the ASB, a large Radar Control subfunction processing requirement will require definition. In addition to the radar control functions concerned directly with the air-to-air, air-to-ground, and terrain following/avoidance capabilities of the radar, the additional associated system level TCA functions will require definition.

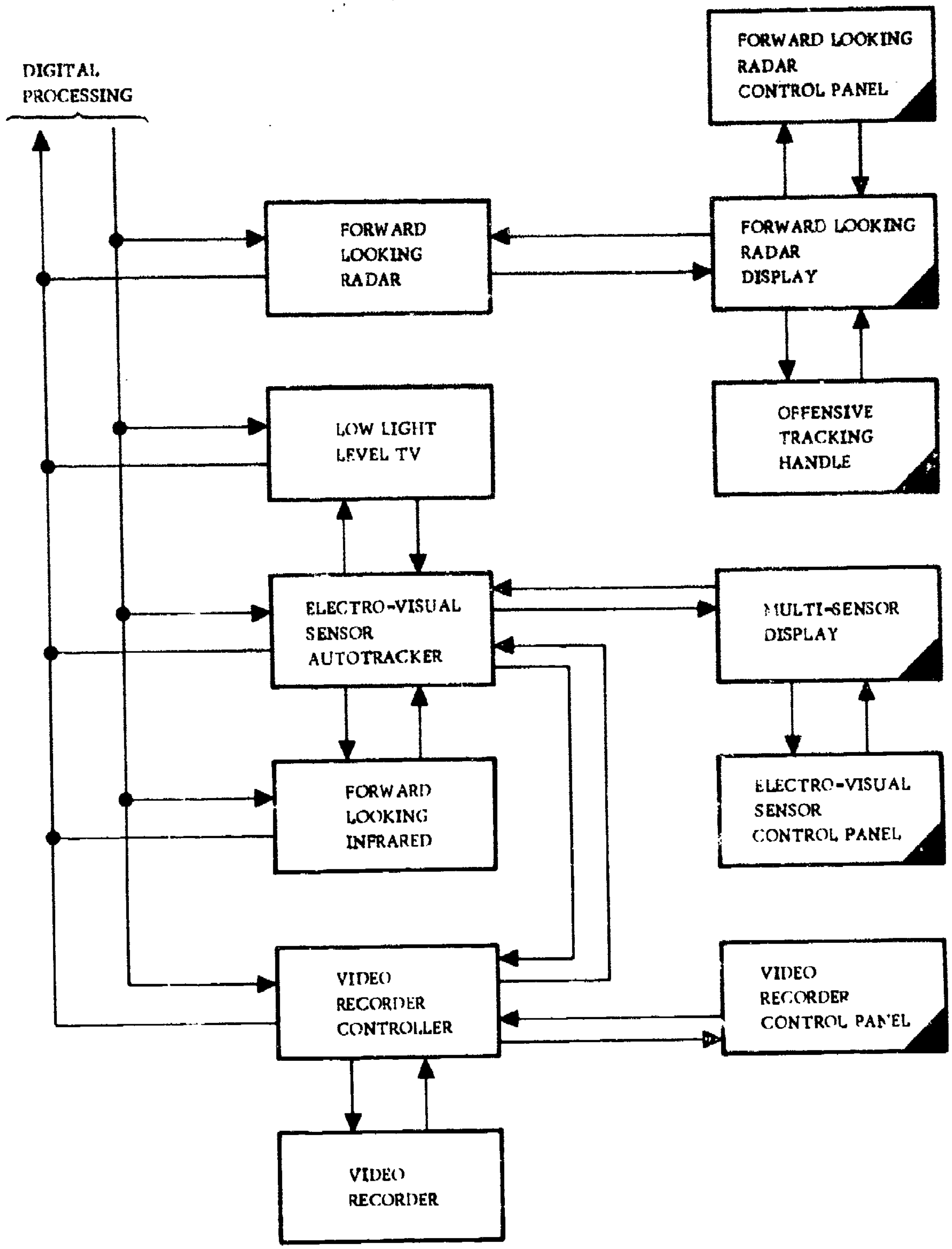

Figure A-5. Target/Checkpoint Acquisition Function Interface Hardware

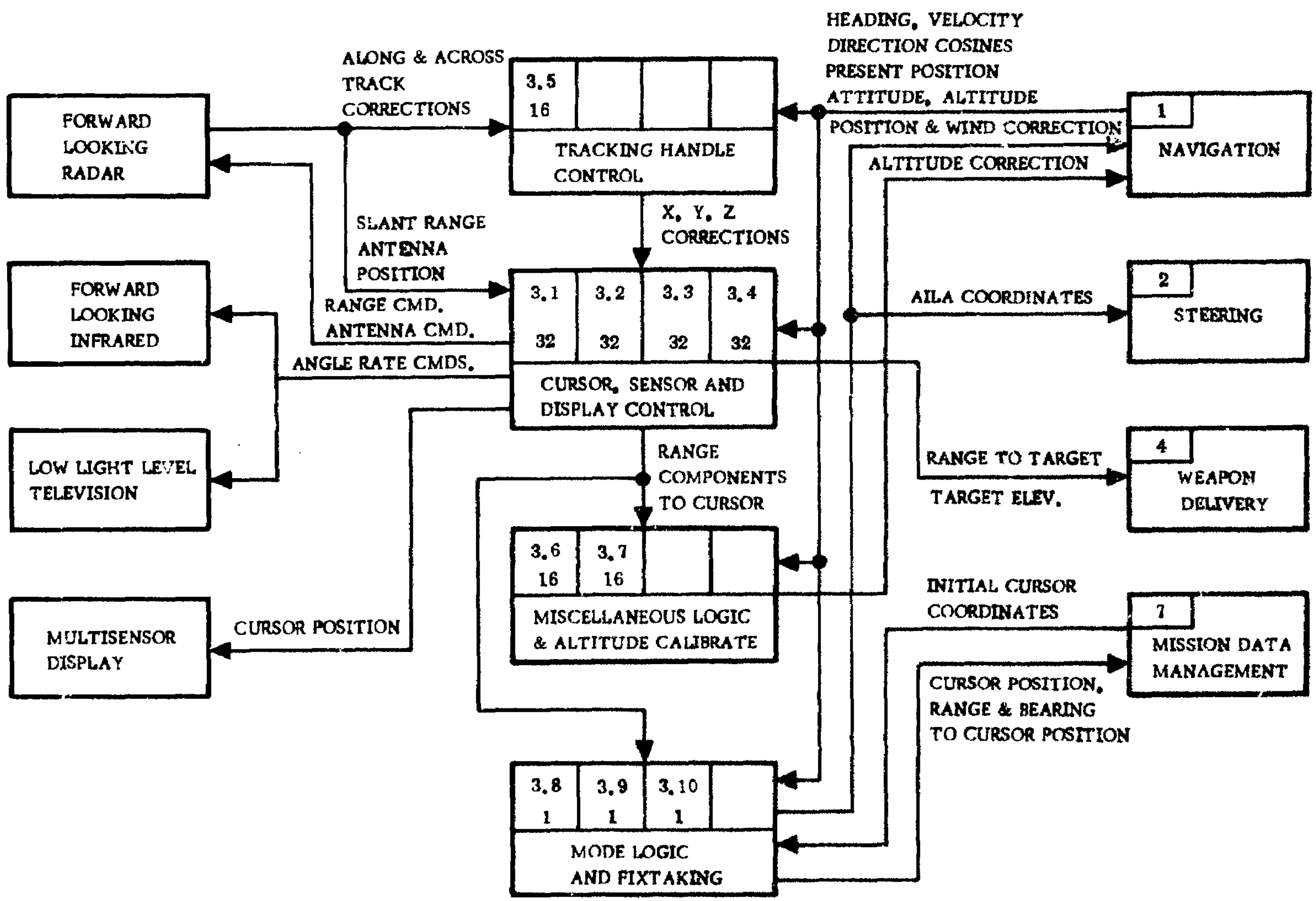

Figure A-6. Target/Checkpoint Acquisition Function Block Diagram

Table A-9. Target/Checkpoint Acquisition Intrafunction Signals

Signal Source Task \ Signal Destination Task	Cursor Control 3.1	FLR Control 3.2	EVS Control 3.3	MSD Command 3.4	Tracking Handle Control 3.5	Mid Rate Logic 3.6	Altitude Calibrate 3.7	Slow Rate Logic 3.8	Position Fix 3.9	Velocity Fix 3.10
3.1 Cursor Control		6	6	6		2	2		6	2
3.2 FLR Control				2			2			
3.3 EVS Control				2						
3.4 MSD Command	2									
3.5 Tracking Handle Control	7									6
3.6 Altitude Calibrate	3									
3.7 Mid Rate Logic								3		
3.8 Slow Rate Logic	18	4	4	4						
3.9 Position Fix								1		
3.10 Velocity Fix								1		

Table A-10. Target/Checkpoint Acquisition Modes and Subfunctions

Subfunctions (Tasks) \ Modes	FLR - Position Fix	FLR - Velocity Fix	FLIR - Position Fix	FLIR - Velocity Fix	LLLTV - Position Fix	LLLTV - Velocity Fix	BDA	Altitude Calibrate	Visual Flyover
3.1 Cursor Control	X	X	X	X	X	X	X	X	
3.2 FLR Control	X	X	X	X	X	X	X	X	
3.3 EVS Control	X	X	X	X	X	X	X	X	
3.4 MSD Command	X	X	X	X	X	X	X	X	
3.5 Tracking Handle Control	X	X	X	X	X	X	X	X	
3.6 Altitude Calibrate	X	X	X	X	X	X	X	X	X
3.7 Mid Rate Logic	X							X	
3.8 Slow Rate Logic	X	X	X	X	X	X	X	X	
3.9 Position Fix	X		X		X				
3.10 Velocity Fix		X		X		X			

Table A-11. Target/Checkpoint Acquisition Processing Requirements Summary

Task	Title	(IT/Sec)	Memory (Words)	Time (KOPS/Sec)
3.1	Cursor Control	32	260	7.87
3.2	FLR Control	32	235	14.97
3.3	EVS Control	32	165	16.64
3.4	MSD Command	32	115	4.48
3.5	Tracking Handle Control	16	245	3.94
3.6	Altitude Calibrate	16	110	1.28
3.7	Mid Rate Logic	16	190	2.24
3.8	Mode Logic - Slow	2	480	2.74
3.9	Position Fix	2	240	3.68
3.10	Velocity Fix	2	100	0.26
	Total		1810	57.84

Table A-12. Target/Checkpoint Acquisition Function Detail Processing Requirements *(Sheet 1 of 2)*

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
3.1	Cursor Control							
	1. EVCS Cursor Initialization 2. Velocity Integration 3. TH and OAP Summation							
	Task Total	1.8	220	40	246	32	7.87	*
3.2	FLR Control							
	1. FLR Command Processing 2. FLR Display Processing							
	Task Total	3.1	210	25	468	32	14.97	*
3.3	EVS Control							
	1. FLIR Command 2. LLLTV Command							
	Task Total	3.2	150	15	520	32	16.64	*
3.4	3. MSD Display Processing							
	Task Total	3.3	100	15	140	32	4.48	*
3.5	Tracking Handle Control							
	1. EVCS Transformation 2. FLR Transformation 3. Correction Summations							
	Task Total	1.9	220	25	246	16	3.94	*
3.6	Altitude Calibrate							
	Task Total	3.5	100	10	80	16	1.28	*

Table A-12. Target/Checkpoint Acquisition Function Detail Processing Requirements (Sheet 2 of 2)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
3.7	Misc - Middle Rate							
	1. Bomb Damage Assessment Logic							
	2. Video Recorder Logic							
	3. Miscellaneous Logic							
	Task Total	3.6	175	15	140	16	2.24	*
3.8	Mode Logic - Slow							
	1. Range Initialization							
	2. Mode Initialization							
	3. Mode Selection							
	4. Miscellaneous Logic							
	Task Total	1.11	270	30	686	4	2.74	*
3.9	Position Fix							
	1. Present Position Update							
	2. Recon Position Fix							
	Task Total	3.8	150	40	920	4	3.68	*
3.10	Velocity Fix							
	1. Initialization							
	2. Closeout							
	Task Total	3.8	80	20	64	4	.26	*
	Function Total		1575	235			58.10	

5. WEAPON DELIVERY

5.1 GENERAL DESCRIPTION

The Weapon Delivery (WD) function provides the capability to deliver both gravity drop and Short Range Attack Missile (SRAM) weapons. The gravity weapons are delivered in a level bomb mode against direct or offset targets. A Low Angle Drouge Delivery (LADD) submode is optional, upon selection. Each delivery mode, i.e., Level, LADD, and SRAM includes Radar Bomb Scoring (RBS) and simulation capability. Simultaneous delivery of both gravity drop and SRAM weapons is possible.

The Weapon Delivery function also provides the data processing associated with the Stores Management Set. Automatic and manual selection capability of offensive (gravity drop and SRAM) and defensive (SRAM) weapons is provided. Automatic selection of weapon delivery mode and weapons is provided based upon pre-established route point sequencing information from the Missile Data Management function. Logic to monitor weapon status, Weapon Interface Unit (WIU) status (in conjunction with CITS), and monitor of selected commands is included. Additional mechanization related to stores arming, option selection, SRAM targeting, and station loading, verification, and release monitoring is provided.

Automatic release signals are issued to the Stores Logic Unit (SLU) upon satisfaction of release criteria.

Attack steering commands are generated by the Weapon Delivery function during a gravity drop weapon delivery mode. The steering function provides the signal command limiting and formatting prior to transmission to the FDC and AFCS.

Figure A-7 shows the major interconnecting hardware elements. A function block diagram is shown in Figure A-8. Subfunction interface signals are listed in Table A-13. Table A-14 details the modes and subfunctions. The memory and throughput requirements are delineated in Tables A-15 and A-16.

5.2 ASSUMPTIONS

1. The Stores Management Subsystem (SMS) is comprised of the Stores Logic Unit (SLU), Stores Management Control Panel, and five WIU's. Hardwired logic within the SMS allow autonomous operation in a manual mode.

2. Manual selection arming, and release (or jettison) of gravity drop may be possible without centralized digital processing.

3. Targeting, arming, and launch of SRAM is possible only with centralized digital processing. Manual selection and jettison of SRAM's is only possible without central processing.

4. Should SRAM launch be required without centralized digital processing, a dedicated processor must be allocated to provide SRAM alignment initialization, targeting, and launch initiation function. Additional processing requirements must then be defined to allow for redundant overhead operations.

5. No decoys or Bomber Defense Missiles (either short or long range) are provided.

6. Only one SRAM at a time can be launched with a minimum of five seconds between launches.

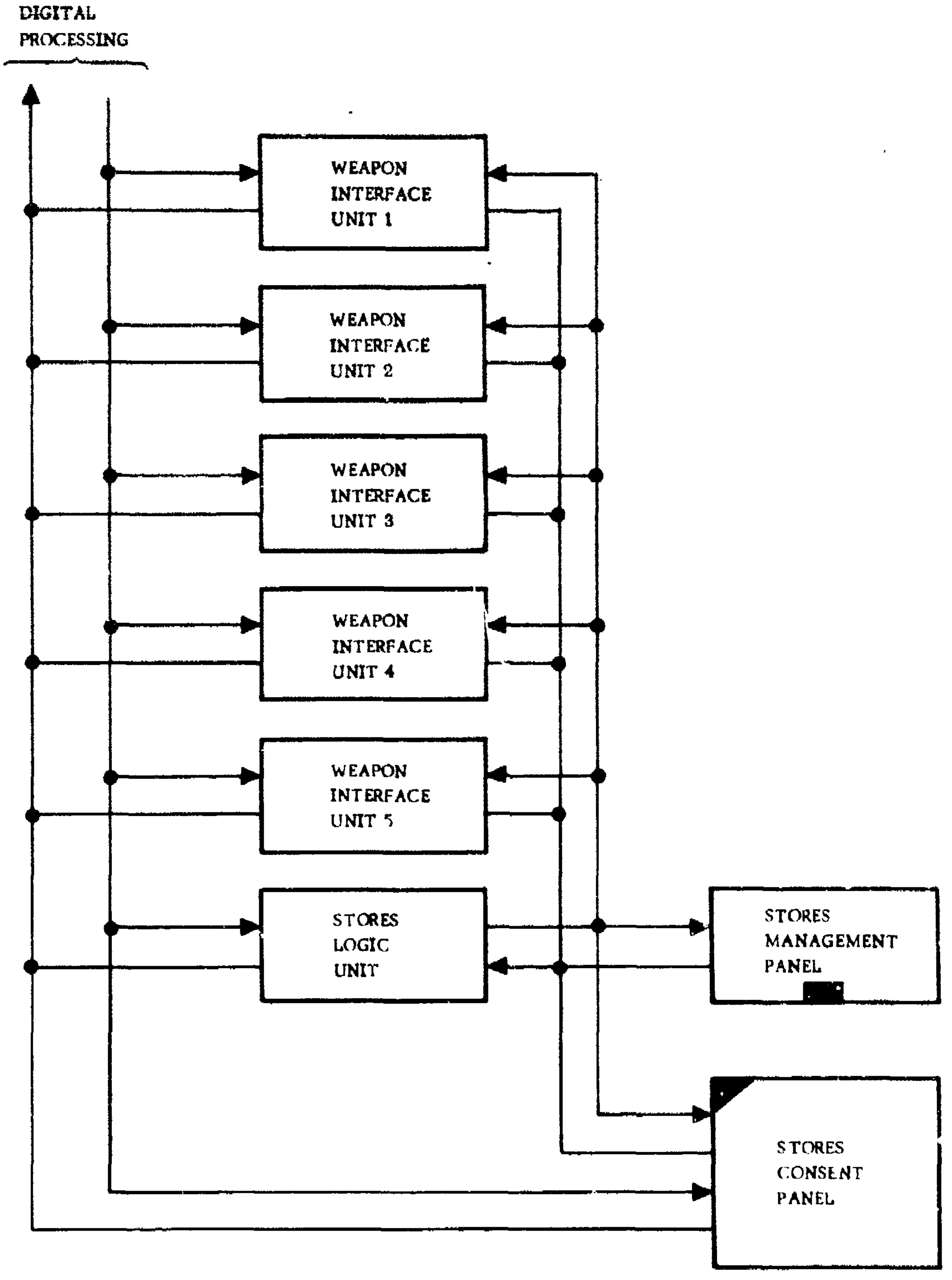

Figure A-7. Weapon Delivery Function Interface Hardware

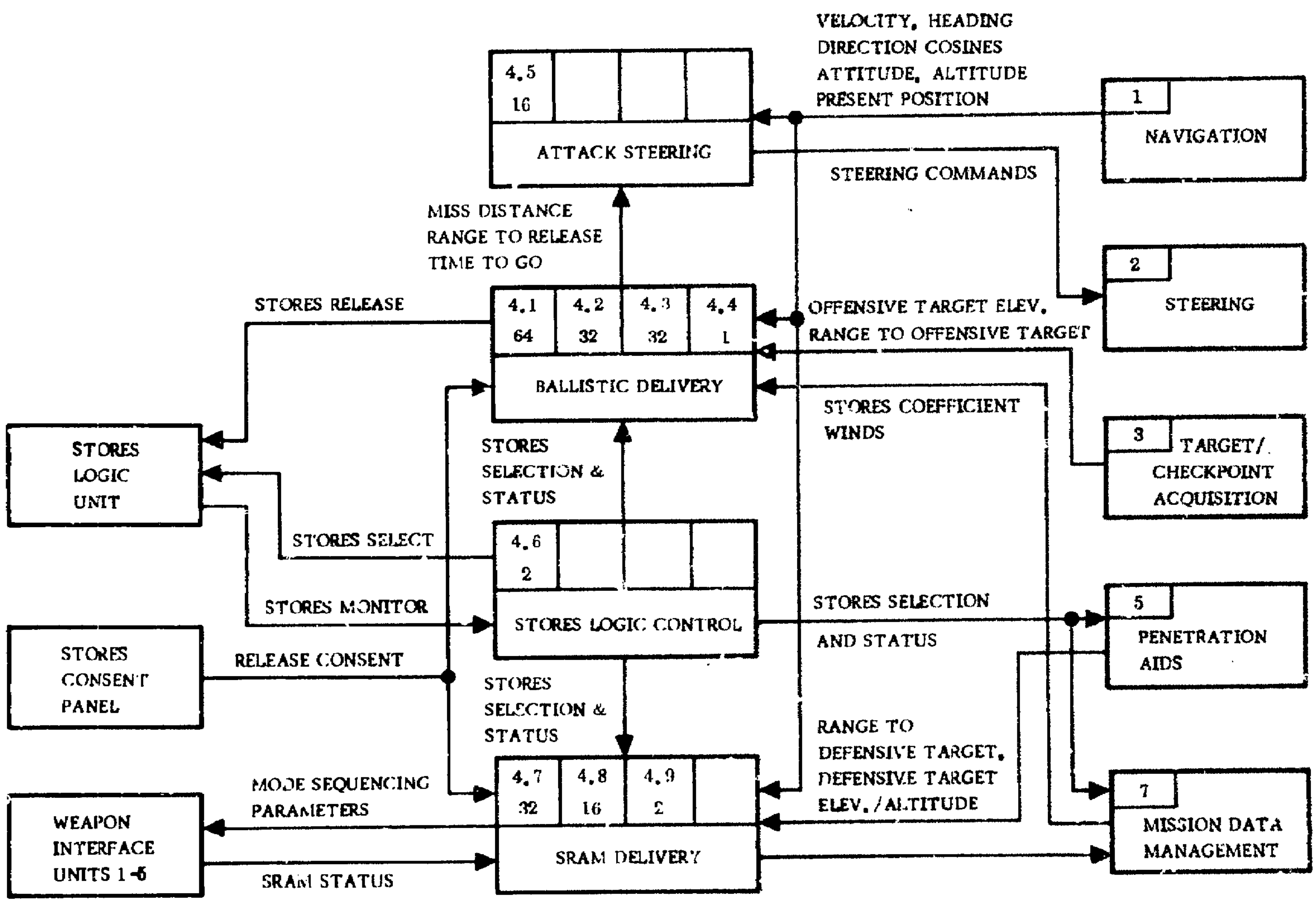

Figure A-8. Weapon Delivery Function Block Diagram

Table A-13. Weapon Delivery Intrafunction Signals

Signal Source Task \ Signal Destination Task	4.1 Bomb Release	4.2 Level Delivery - Fast	4.3 Drogue Delivery - Fast	4.4 Level Delivery - Slow	4.5 Attack Steering	4.6 Stores Logic Control	4.7 SRAM Delivery - Fast	4.8 SRAM Delivery - Mid	4.9 SRAM Delivery - Slow
4.1 Bomb Release							4		
4.2 Level Delivery - Fast	8		4	12	8	4			
4.3 Drogue Delivery - Fast	2								
4.4 Level Delivery - Slow	12								
4.5 Attack Steering									
4.6 Stores Logic Control		6							6
4.7 SRAM Delivery - Fast								12	10
4.8 SRAM Delivery - Mid							6		6
4.9 SRAM Delivery - Slow							8	4	

Table A-14. Weapon Delivery Function Modes and Subfunctions

Subfunctions (Tasks) \ Modes	Weapon Del not Selected	Level Bomb	Drogue Bomb	SRAM	Level or Drogue & SRAM
4.1 Bomb Release		X	X		X
4.2 Level Delivery - Fast		X			X
4.3 Drogue Delivery - Fast			X		X
4.4 Level Delivery - Slow		X	X		X
4.5 Attack Steering		X	X		X
4.6 Stores Logic Control	X	X	X		X
4.7 SRAM Delivery - Fast				X	X
4.8 SRAM Delivery - Mid				X	X
4.9 SRAM Delivery - Slow				X	X

Table A-15. Weapon Delivery Processing Requirements Summary

Task	Title	(IT/Sec)	Memory (Words)	Time (KOPS/Sec)
4.1	Bomb Release	64	390	17.28
4.2	Level Delivery - Fast	32	600	20.80
4.3	Drogue Delivery - Fast	32	300	6.40
4.4	Level Delivery - Slow	1	1190	1.38
4.5	Attack Steering	16	475	10.24
4.6	Stores Logic Control	2	2915	3.64
4.7	SRAM Delivery - Fast	32	95	1.92
4.8	SRAM Delivery - Mid	16	1820	18.69
4.9	SRAM Delivery - Slow	2	2460	2.89
			10,245	83.24

Table A-16. Weapon Delivery Function Detail Processing Requirements (Sheet 1 of 2)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
4.1	Bomb Release							
	1. Single Release 2. Multiple Release							
	Task Total	-	350	40	270	64	17.28	*
4.2	Level Delivery - Fast							
	1. Minor Cycle							
	Task Total	3.1	550	50	650	32	20.80	*
4.3	Drogue Delivery - Fast							
	1. LADD Logic							
	Task Total	4.2	250	50	200	32	6.40	*
4.4	Level Delivery - Slow							
	1. Major Cycle 2. Simulate							
	Task Total	9.1	1125	65	1380	1	1.38	*
4.5	Attack Steering							
	1. Attack Steering Processing							
	Task Total	1.9	450	25	640	16	10.24	*
4.6	Stores Logic Control							
	1. Gravity Weapon Logic 2. Station/ID Table Process 3. Weapon Status Logic 4. Arming/Fuzing Status 5. Controls & Displays Logic							

Table A-16. Weapon Delivery Function Detail Processing Requirements (Sheet 2 of 2)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
4.6 (Cont)	6. Mode/Store Unsat. Logic							
	7. CG/FM Computers Interface							
	8. Missile Wpn Logic Control							
	9. Weapon ID's (Ballistics Table) (75 types)							
	10. Weapon ID's (Ballistics Table) (15 Generic Types)							
	11. Wpn ID's Bay Door Opening							
	Task Total	3.1	1575	1340	1820	2	3.64	*
4.7	SRAM Delivery - Fast							
	1. Time to Release							
	Task Total	1.8	75	20	60	32	1.92	*
4.8	SRAM Delivery - Mid							
	1. SRAM Selection & Test							
	2. Launch Sequence Logic							
	Task Total	5.11	1460	360	1168	16	18.69	*
4.9	SRAM Delivery - Slow							
	1. Range Calculations							
	2. Target Range & Bearing							
	3. Target Coordinates							
	4. Target Motion							
	5. Guidance Constants							
	6. Low Altitude Trajectory							
	7. Semi Ballistic Trajectory							
	8. Skip Trajectory							
	9. SRAM Selection & Test							
	Task Total	1.12	1805	655	1444	2	2.89	*
	Function Total		7640	2605			83.24	

6. PENETRATION AIDS FUNCTION

6.1 GENERAL DESCRIPTION

The Penetration Aids function provides the means to evaluate and counter hostile threats. This is accomplished by detecting, identifying, and locating the threats by analyzing the electromagnetic environment. The discovered threats are evaluated as to their threat priority. Their identification, location, and priority are displayed on the Threat Situation Display (TSD) for operator evaluation. Determined characteristics of the threat emitters are similarly displayed on the Threat Data Display (TDD). Automatic and/or manual threat countermeasure action can be initiated by electromagnetic transmission (ECM), dispensables (chaff, flares, etc), and/or defensive weapons (e.g., SRAM).

Two major subsystems provide primary inputs to the Penetration Aids function. They are the Radio Frequency Surveillance/Electronic Countermeasure subsystem (RFS/ECMS) and the Infrared Surveillance Subsystem (IRSS). Both subsystems contain sensors to detect electromagnetic activity in their respective spectrum. The RFS/ECMS also contains a tighly coupled and responsive ECM transmission capability. These two subsystems are self-contained and operate autonomously in conjunction with the TSD, TDD, and Penetration Aids Control Panel (PACP) to provide a limited penetration aids capability. When augmented with the central processing capability to provide navigation, weapon delivery, and mission data management information, along with additional hardware subsystems such as the Dispensables Control Set (DCS) and defensive weapons, a total penetration aids capability results.

Figure A-9 shows the major interconnecting hardware elements. A function block diagram is shown in Figure A-10. Subfunction interface signals are listed in Table A-17. Table A-18 details the modes and subfunctions. Memory and throughput requirements are delineated in Tables A-19 and A-20.

6.2 ASSUMPTIONS

1. No special purpose processing is included in the digital processing requirements which can best be performed by special purpose devices, e.g., fourier transform spectrum analysis.

2. No autonomous operation of either the RFS/ECMS or the IRSS is required that would necessitate digital processing. Should this requirement be imposed on the ASE avionics system, the dedicated preprocessor requirements must be segmented out of the total Penetration Aid requirements and allocated to the RFS/ECMS and IRSS subsystem. Additional requirements will then require definition to provide redundant support functions, i.e., executive, common subroutines, data entry/display, and data storage. The central processor to dedicated preprocessor intercommunications requirements must also be defined.

3. No expendable countermeasures, i.e., decoys, are included in the present avionics systems configuration.

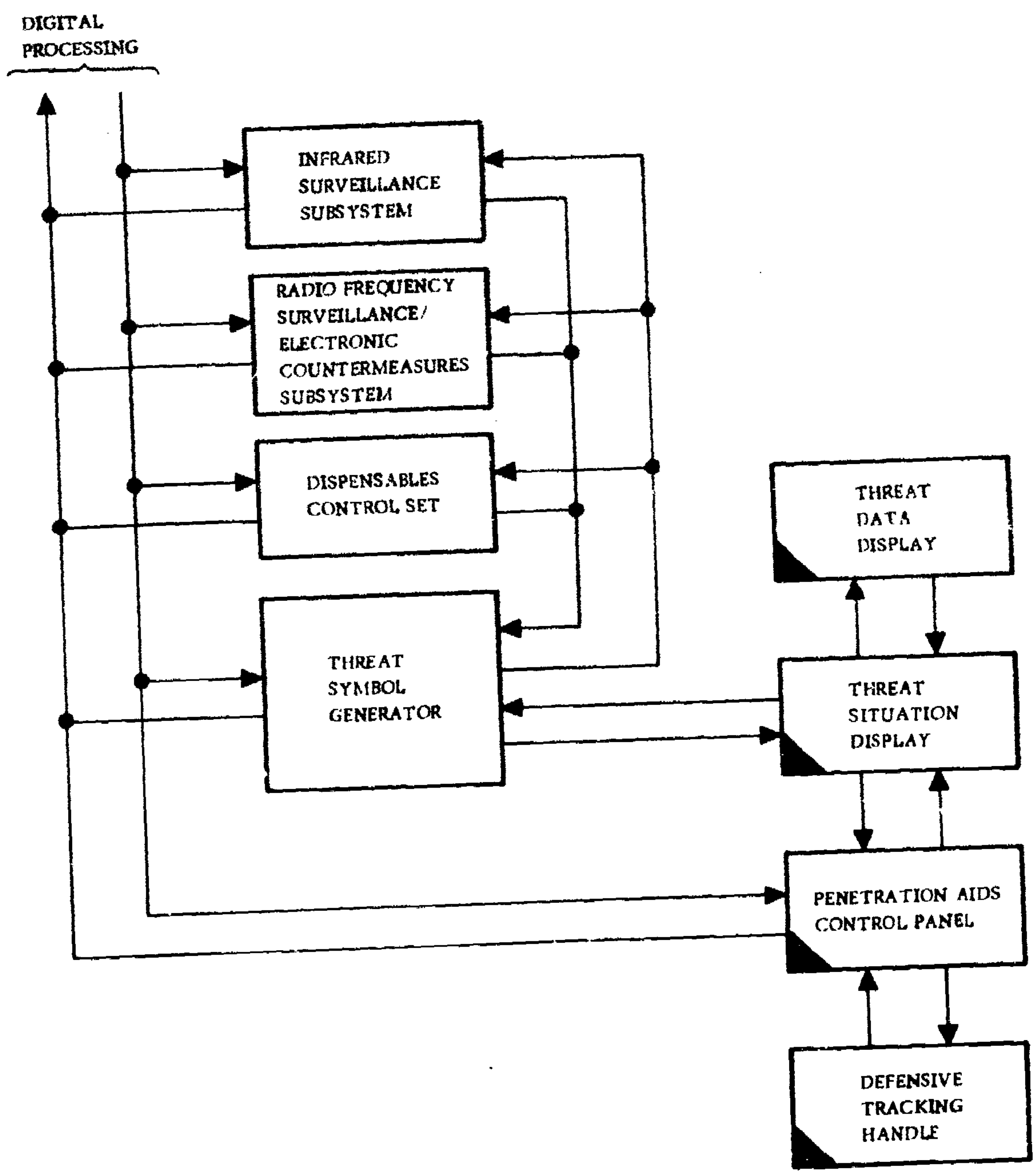

Figure A-9. Penetration Aids Function Interfacing Hardware

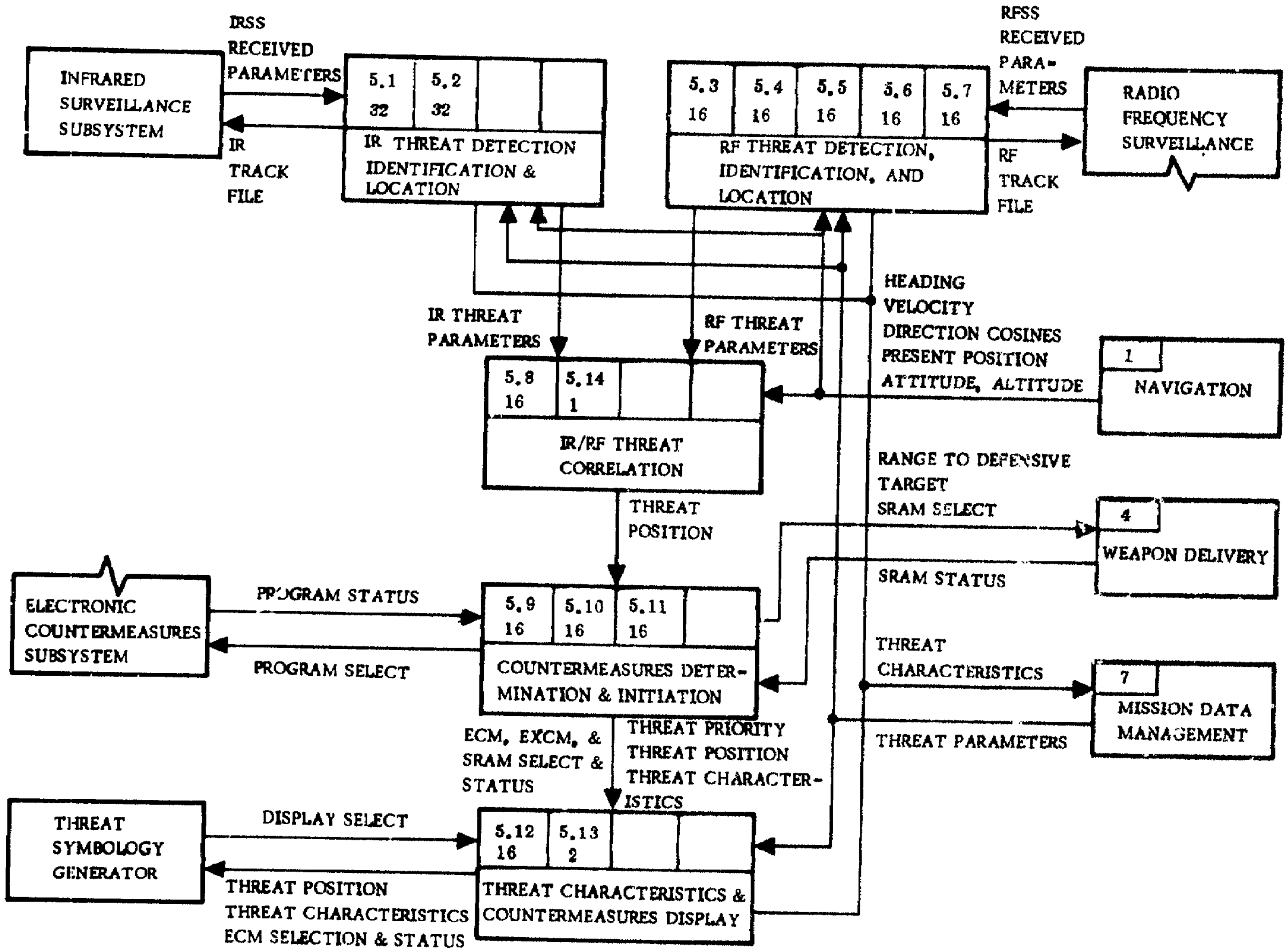

Figure A-10. Penetration Aids Function Block Diagram

Table A-17. Penetration Aids Intrafunction Signals

Signal Source Task \ Signal Destination Task	5.1 Identify IR Threat	5.2 IR Track File Processing	5.3 RF Known Emitter Sort	5.4 RF Characteristics Calcu.	5.5 RF Exotic ID Logic	5.6 Identify RF Threat	5.7 RF Track File Processing	5.8 Correlate RF/IR Threat	5.9 Determine Optimum CM	5.10 Use Onboard CM	5.11 Use Offboard CM	5.12 TSD Command - Fast	5.13 TSD Command - Slow	5.14 RF Passive Ranging Filter
5.1 Identify IR Threat		48						36				24		
5.2 IR Track File Processing	48													
5.3 RF Known Emitter Sort				96										
5.4 RF Characteristics Calcu.					48									
5.5 RF Exotic ID Logic						48								
5.6 Identify RF Threat							96	96				72		24
5.7 RF Track File Processing						96								
5.8 Correlate RF/IR Threat		4					4		16					
5.9 Determine Optimum CM										8	8	8	8	
5.10 Use Onboard CM												8	8	
5.11 Use Offboard CM												8	8	
5.12 TSD Command - Fast														
5.13 TSD Command - Slow														
5.14 RF Passive Ranging Filter						24								

Table A-18. Penetration Aids Modes and Subfunctions

Subfunctions (Tasks) \ Modes	Evaluate IR Environment	Evaluate RF Environment	Evaluate Total Environ.	Manual CM	Automatic CM
5.1 Identify IR Threat	X		X		
5.2 IR Track File Processing	X		X		
5.3 RF Known Emitter Sort		X	X		
5.4 RF Characteristics Calu.		X	X		
5.5 RF Exotic ID Logic		X	X		
5.6 Identify RF Threat		X	X		
5.7 RF Track File Processing		X	X		
5.8 Correlate RF/IR Threat	X	X	X		
5.9 Determine Optimum CM				X	X
5.10 Use Onboard CM					X
5.11 Use Offboard CM					X
5.12 TSD Command - Fast	X	X	X		
5.13 TSD Command - Slow	X	X	X		
5.14 RF Passive Ranging Filter	X	X	X		

Table A-19. Penetration Aids Processing Requirements Summary

Task	Title	(IT/Sec)	Memory (Words)	Time (KOPS/Sec)
5.1	Identify IR Threat	32	1800	50.80
5.2	IR Track File Processing	32	1600	17.92
5.3	RF Known Emitter Sort	16	3600	20.48
5.4	RF Characteristics Calculation	16	800	7.68
5.5	RF Exotic ID Logic	16	4500	25.60
5.6	Identify RF Threat by Location	16	2400	23.04
5.7	RF Track File Processing	16	2200	16.64
5.8	Correlate RF/IR Threat	16	2100	25.60
5.9	Determine Optimum CM	16	900	5.12
5.10	Use Onboard CM	16	900	7.68
5.11	Use Offboard CM	16	800	7.68
5.12	TSD Command - Fast	16	800	8.96
5.13	TSD Command - Slow	2	1600	1.60
5.14	RF Passive Ranging Filter	1	1500	1.56
			25,500	220.36

Table A-20. Penetration Aids Function Detail Processing Requirements (Sheet 1 of 2)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
5.1	Identify IR Threat							
	Task Total	1.8	1650	150	1590	32	50.80	*
5.2	IR Track File Processing							
	Task Total	5.1	700	900	560	32	17.92	*
5.3	RF Known Emitter Sort							
	Task Total	1.9	1600	2000	1280	16	20.48	*
5.4	RF Characteristics Calculation							
	1. Pulse Repetition Interval 2. Scan Interval							
	Task Total	5.3	600	200	480	16	7.68	*
5.5	RF Exotic ID Logic							
	Task Total	5.4	2000	2500	1600	16	25.60	*
5.6	Identify RF Threat by Location							
	Task Total	5.5	1800	600	1440	16	23.04	*
5.7	RF Track File Processing							
	Task Total	5.6	1300	900	1040	16	16.64	*
5.8	Correlate RF/IR Threat							
	Task Total	5.7	2000	100	1600	16	25.60	*
5.9	Determine Optimum CM							
	Task Total	5.8	400	500	320	16	5.12	*

Table A-26. Penetration Aids Function Detail Processing Requirements (Sheet 2 of 2)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
5.10	Use Onboard CM							
	Task Total	5.9	600	300	480	16	7.68	*
5.11	Use Offboard CM 1. Dispersables 2. Defensive Weapons							
	Task Total	5.10	600	200	480	16	7.68	*
5.12	TSD Command - Fast							
	Task Total	5.11	700	100	560	16	8.96	*
5.13	TSD Command - Slow							
	Task Total	1.12	1000	600	800	2	1.60	*
5.14	RF Passive Ranging Filter							
	Task Total	-	1000	500	1560	1	1.56	*
	Function Total		15950	9550			220.36	

7. TERRAIN FOLLOWING/AVOIDANCE FUNCTION

7.1 GENERAL DESCRIPTION

In the present B-1 avionics system, the Terrain Following/Avoidance (TFA) function is a growth digital processing function. The TFA mechanization is currently provided in the predominately analog Terrain Following Radar (TFR). The only requirement that presently exists is for the issuance of steering commands. These commands are the Display Depression, Drift Plus Lead Into Turn, Inertial Flight Vector, and Inertial Groundspeed signals. The minimal digital processing requirements to issue these signals are listed in the Navigation function (Section 2).

7.2 ASSUMPTIONS

Should a digital TFR be incorporated in the ASB avionics system, this separate section would be used to delineate the general purpose digital processing requirements to implement the expanded TFA function. This function would include the mechanization to provide the capability to perform low altitude, high speed flight over all types of terrain. A control mechanization would be required to operate and control the advanced TFR. The TFR would either be a separate subsystem or combined in the advanced Electronically Agile Radar (EAR).

8. MISSION DATA MANAGEMENT

8.1 GENERAL DESCRIPTION

The Mission Data Management (MDM) function provides the basic interface between the avionics system operating functions and the mission oriented information handling capability. As such the MDM function provides the basic operating interface with the mission oriented hardware. This equipment is the Mission Data Cartridge Reader (MDCR) and the Mission Data Tape Recorder (MDTR). The primary interface with the Offensive Subsystem and Defensive Subsystem operators is provided through the interface with the Offensive Integrated Control Panel (OICP) and Defensive Integrated Control Panel (DICP). Interface with the off-line Mass Memory Unit (MMU) is also provided.

Pre-selected mission data in the form of flight profile, i.e., target, offset aim-point, checkpoint (of fix point), and destination coordinates and mission sequence are included on the Mission Data Tape (MDT). The MDT information is loaded on-line either automatically or manually. Other information on the MDT includes pre-established weapon selection and arming sequences, wind profiles, and countermeasures selection. Multiple sets of mission information is included for alternate missions.

In flight recorded information concerned with occurrence of mission events are recorded on the MDTR for post flight reconstruction and analysis. Such data includes present position coordinate and time references, designated event times and associated data, target and threat locations (both pre-established and in-flight determined), as well as weapon and counter-measure expenditure status.

The MMU contains the primary flight computer program load information as well as reduced capability reconfiguration programs. The Executive function in the computer controls the on-line loading of these programs. Fault Isolation and Pre-flight Ground Readiness test programs are stored for loading on-line under control of the CITS program. Also multiple mission data sets loaded from the MDCR are recorded on the MMU for rapid and backup access.

Manual data entry capability is provided through use of the OICP and DICP. Automatic data display upon selection and data redisplay upon data entry is provided. Mode verification lamps are illuminated on these panels, also.

Other miscellaneous subfunctions include mission data verification, protection, and destruct capabilities. Cruise control processing is also provided.

Figure A-11 shows the major interconnecting hardware elements. A function block diagram is shown in Figure A-12. Subfunction interface signals are listed in Table A-21. Table A-22 details the modes and subfunctions. The memory and throughput requirements are delineated in Tables A-23 and A-24.

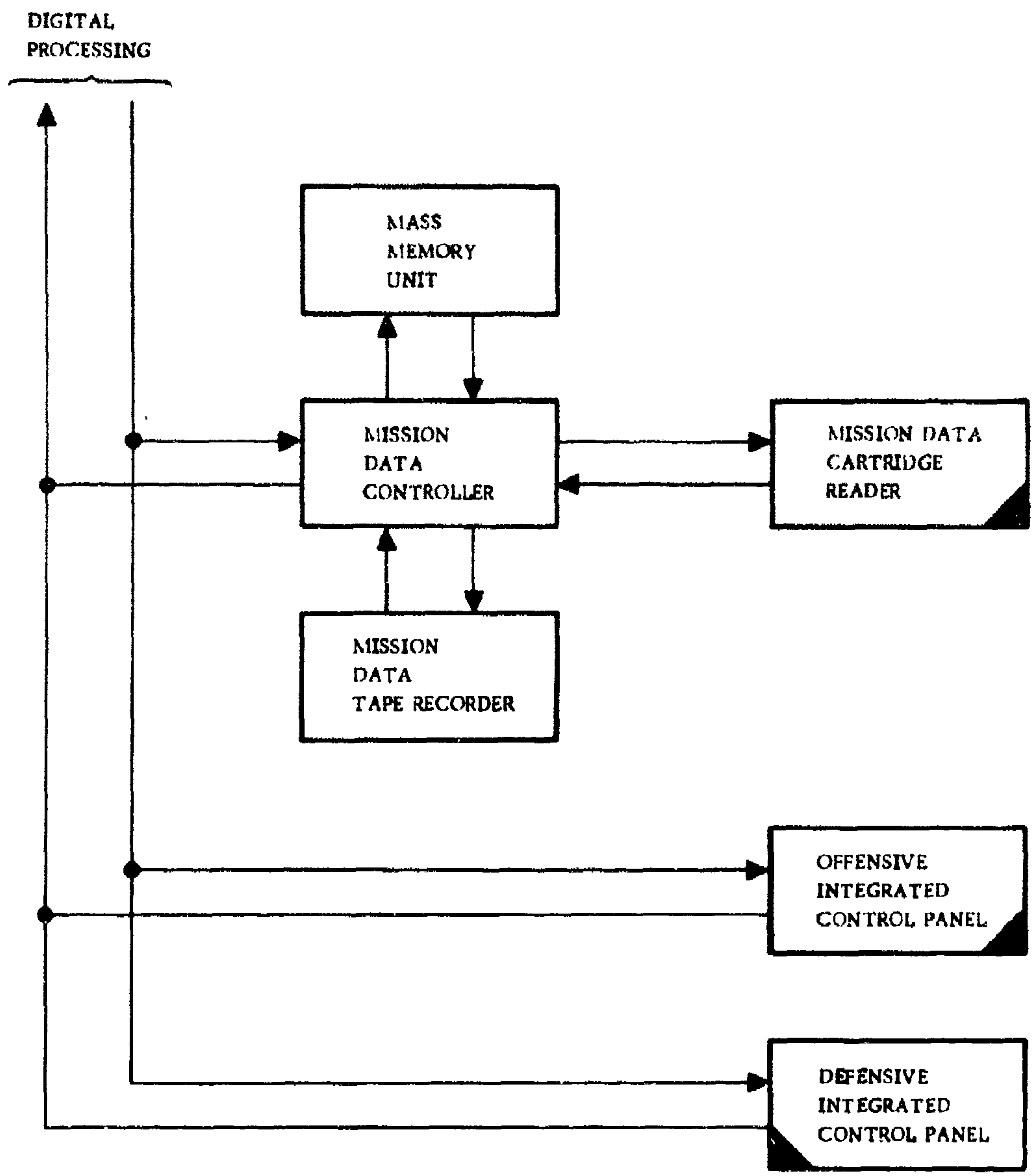

Figure A-11. Mission Data Management Equipment Interconnection Diagram

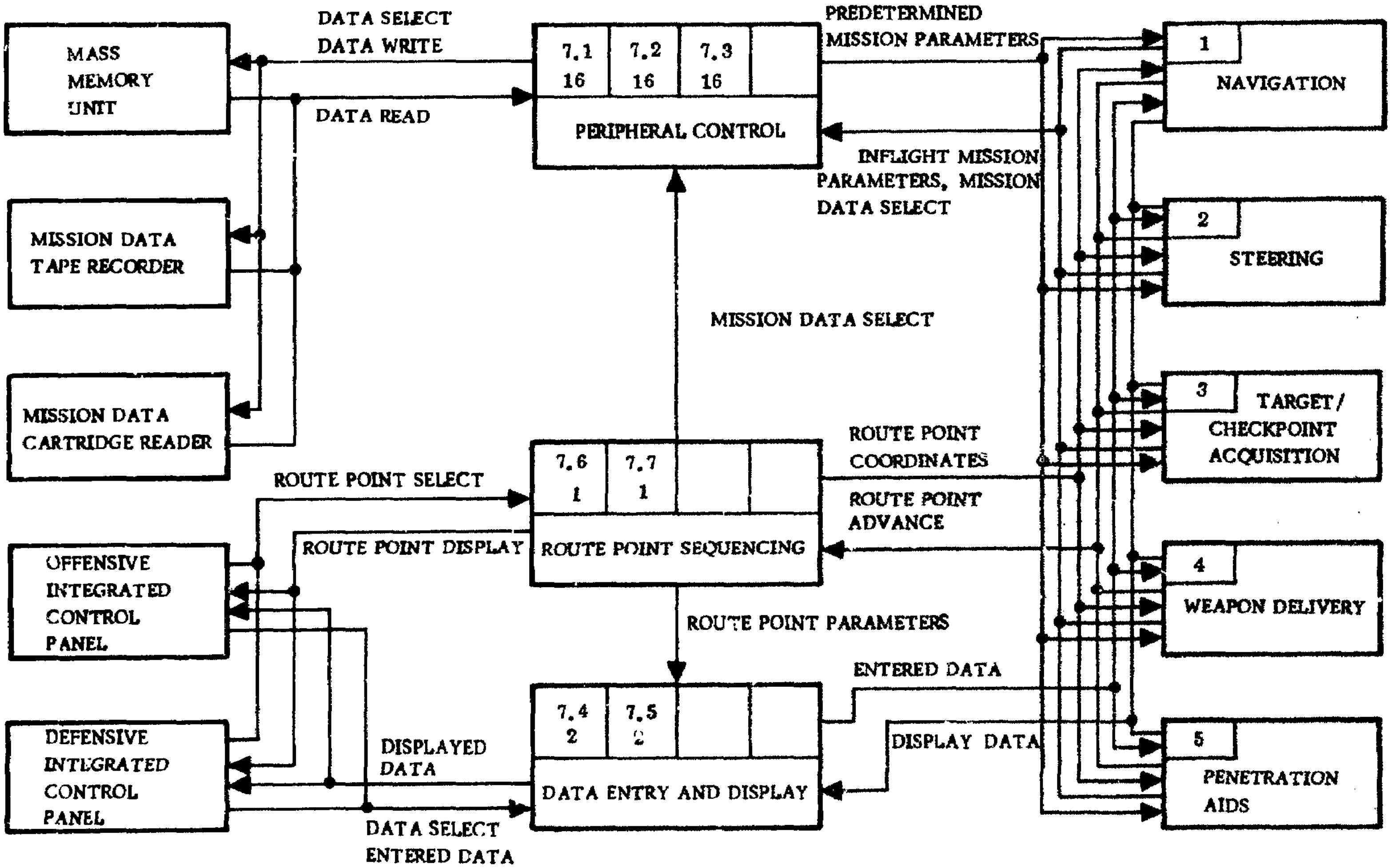

Figure A-12. Mission Data Management Function Block Diagram

Table A-21. Mission Data Management Intrafunction Signals

Signal Source Task \ Signal Destination Task	7.1 MMU Control	7.2 MDTR Control	7.3 MDCR Control	7.4 Cruise Control	7.5 Data Entry & Display	7.6 Route Point Sequencing	7.7 Mission Data Protect
7.1 MMU Control							2
7.2 MDTR Control							2
7.3 MDCR Control				4		24	2
7.4 Cruise Control					4		
7.5 Data Entry & Display				4		10	
7.6 Route Point Sequencing		10	4		10		
7.7 Mission Data Protect	4		6				

Table A-22. Mission Data Management Modes and Subfunctions

Subfunctions (Tasks) \ Modes	Auto Cruise Control	Manual Cruise Control	Data Entry	Data Display	Auto Route Pt Seq	Manual Route Pt Seq	Load Mission Data
7.1 MMU Control	X	X					X
7.2 MDTR Control							X
7.3 MDCR Control	X	X					
7.4 Cruise Control	X						
7.5 Data Entry & Display			X	X			
7.6 Route Point Sequencing					X	X	
7.7 Mission Data Protect		X					

Table A-23. Mission Data Management Processing Requirements Summary

Task	Title	(IT/Sec)	Memory (Words)	Time (KOPS/Sec)
7.1	MMU Control	16	350	3.97
7.2	MDTR Control	16	620	7.17
7.3	MDCR Control	16	350	3.97
7.4	Cruise Control	2	345	0.43
7.5	Data Entry and Display	2	780	1.12
7.6	Route Point Sequencing	1	1345	0.52
7.7	Mission Data Protect	1	495	0.34
	Total		4285	17.52

Table A-24. Mission Data Management Function Detail Processing Requirements (Sheet 1 of 2)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
7.1	MMU Control							
	1. Initialize/Terminate 2. Search 3. Read 4. Verify							
	Task Total	5.13	310	40	248	16	3.97	*
7.2	MDTR Control							
	1. Initialize/Terminate 2. Record Control 3. Formatting 4. Verify							
	Task Total	7.1	560	60	448	16	7.17	*
7.3	MDCR Control							
	1. Initialize/Terminate 2. Search 3. Read 4. Verify							
	Task Total	7.2	310	40	248	16	3.97	*
7.4	Cruise Control							
	1. Input Processing 2. Computations 3. Output Processing							
	Task Total	1.12	270	75	216	2	0.43	*

Table A-24. Mission Data Management Function Detail Processing Requirements (Sheet 2 of 2)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
7.5	Data Entry and Display							
	1. Data Entry							
	2. Data Display							
	Task Total	1.12	700	80	560	2	1.12	*
7.6	Route Point Sequencing							
	1. Initialization							
	2. Steer Point Criteria							
	3. Cursor Point Criteria							
	4. Manual Sequencing							
	Task Total	9.1	650	695	520	1	0.52	*
7.7	Mission Data Protection							
	1. Input/Output Verification							
	2. Data Destruct							
	3. Data/Program Protect							
	Task Total	9.1	425	70	340	1	0.34	*
	Function Total		3225	1060			17.52	

9. MISSION AND TRAFFIC CONTROL

9.1 GENERAL DESCRIPTION

Mission and Traffic Control (M&TC) is a growth function (as far as being integrated into the avionics system) in the present B-1 Avionics System configuration and as such no processing requirements presently exist for this function.

10. CENTRAL INTEGRATED TEST SUBSYSTEM

10.1 GENERAL DESCRIPTION

The Central Integrated Test Subsystem (CITS) function performs the overall inflight system performance monitoring, fault detection, and fault isolation testing. Preflight ground readiness testing is also performed. Systems status and fault annunciation is provided by illumination of cockpit display lamps, printout on a cockpit printer, and recording on magnetic tape recorder. Permanent on-line programs include the avionics system monitoring and fault detection programs. Fault isolation programs are stored off-line. Appropriate fault isolation programs are loaded on-line in response to a detected fault in order to isolate the fault to a line replaceable unit (LRU).

The CITS function merges the non-avionics tests with the avionics tests to form one integrated subsystem. This subsystem includes all the hardware elements required to perform the CITS function as well as the software. This hardware includes five non-avionics Data Acquisition Units (DAU's). Each DAU samples test point information and converts it to digital format for transmission to the central processor. Other CITS hardware elements include the CITS Control Panel (CPP), the CITS Status Panels in both front and rear cockpits (CSPF and CSPR), the CITS Printer (CPR), the CITS Tape Recorder (CTR), and the CITS Maintenance Panel (CMP).

Figure A-13 shows the major interconnecting hardware elements. A function block diagram is shown in Figure A-14. Subfunction interface signals are listed in Table A-25. Table A-26 details the modes and subfunctions. The memory and throughput requirements are delineated in Tables A-27 and A-28.

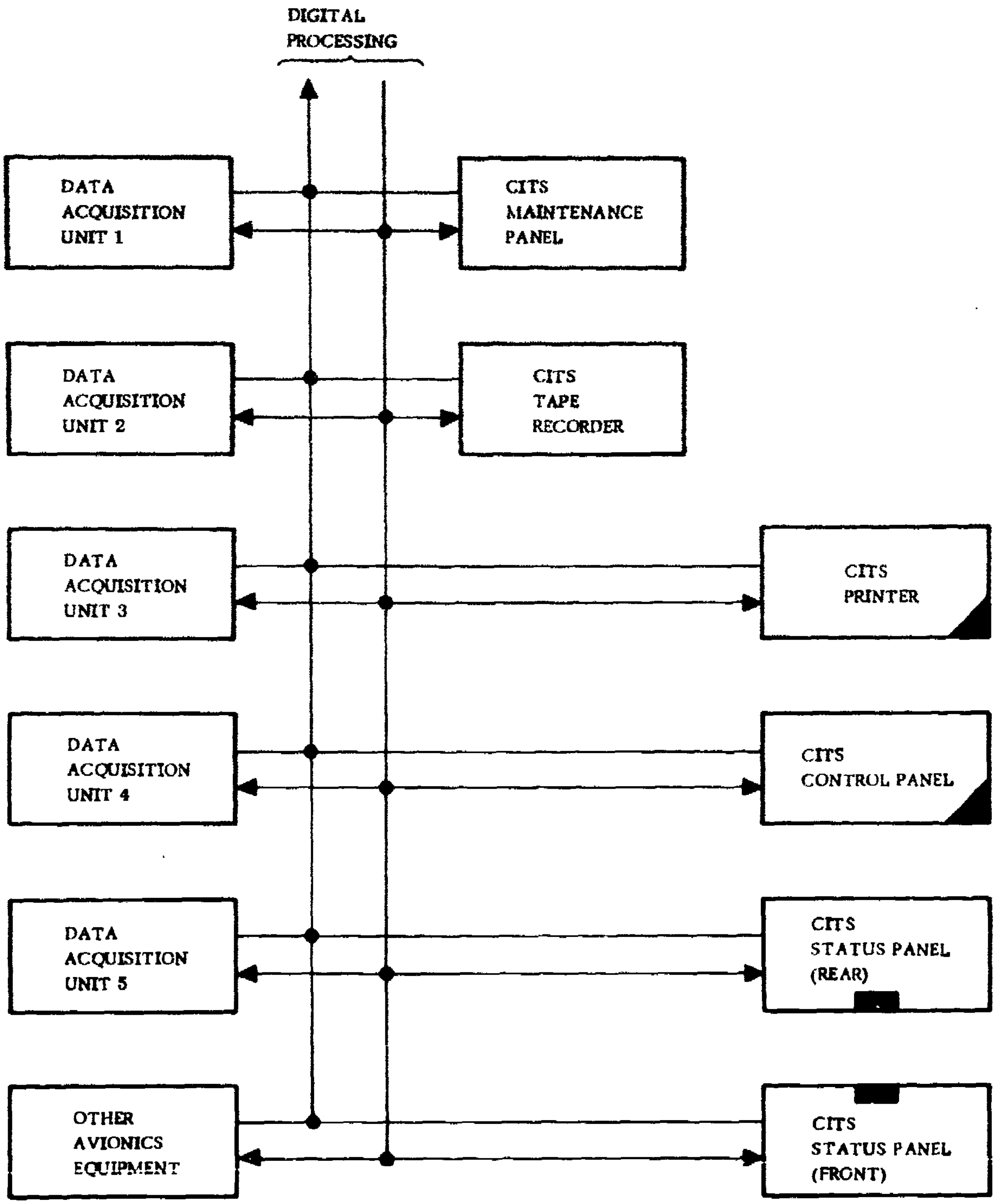

Figure A-13. CITS Function Interfacing Hardware

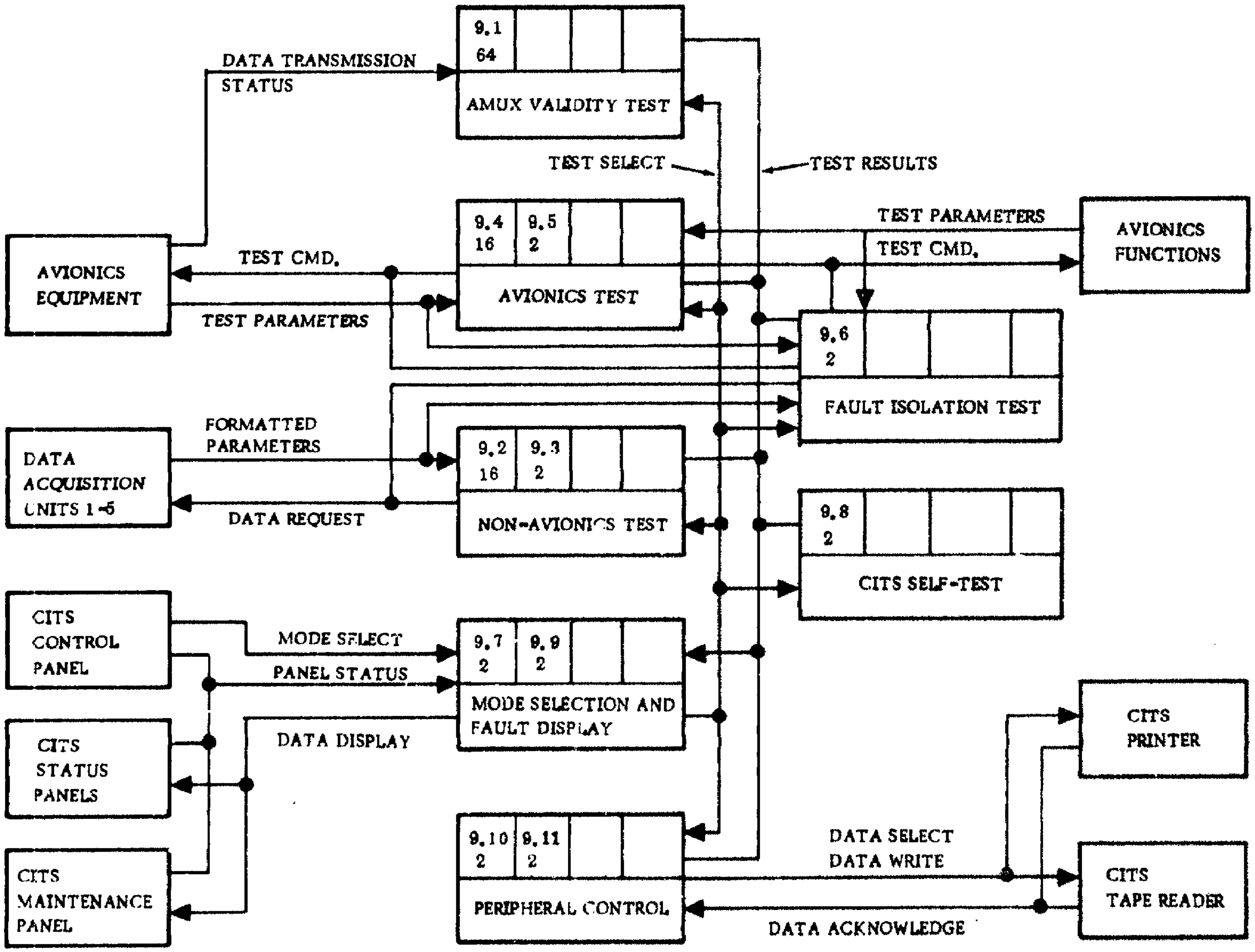

Figure A-14. CITS Function Block Diagram

Table A-25. CITS Intrafunction Signals

Signal Source Task \ Signal Destination Task	9.1 AMUX Validity Test	9.2 Non-Avionics Test-Fast	9.3 Non-Avionics Test-Slow	9.4 Avionics Test-Fast	9.5 Avionics Test-Slow	9.6 Fault Isolation Test	9.7 Mode Selection	9.8 CITS Self-Test	9.9 CITS Display Control	9.10 CITS Printer Control	9.11 CITS Recorder Control
9.1 AMUX Validity Test									48	48	48
9.2 Non-Avionics Test - Fast									48	48	48
9.3 Non-Avionics Test - Slow									48	48	48
9.4 Avionics Test - Fast									24	24	24
9.5 Avionics Test - Slow									24	24	24
9.6 Fault Isolation Test									48	48	48
9.7 Mode Selection	2	4	4	4	4	3		3	2	2	2
9.8 CITS Self-Test									10	10	10
9.9 CITS Display Control											
9.10 CITS Printer Control											
9.11 CITS Recorder Control											

Table A-26. CITS Function Modes and Subfunctions

Subfunction's (Tasks) \ Modes		Performance Monitoring	Fault Isolation
9.1	AMUX Validity Test	X	X
9.2	Non-Avionics Test-Fast	X	X
9.3	Non-Avionics Test-Slow	X	X
9.4	Avionics Test-Fast	X	X
9.5	Avionics Test-Slow	X	X
9.6	Fault Isolation Test		X
9.7	Mode Selection	X	X
9.8	CITS Self-Test	X	X
9.9	CITS Display Control	X	X
9.10	CITS Printer Control	X	X
9.11	CITS Recorder Control	X	X

Table A-27. CITS Processing Requirements Summary

Task	Title	(IT/Sec)	Memory (Words)	Time (KOPS/Sec)
9.1	AMUX Validity Test	64	331	27.65
9.2	Non-Avionics Test-Fast	16	1100	12.80
9.3	Non-Avionics Test-Slow	2	6000	8.00
9.4	Avionics Test-Fast	16	365	4.48
9.5	Avionics Test-Slow	2	2895	4.43
9.6	Fault Isolation Test	2	2200	3.20
9.7	Mode Selection	2	260	0.40
9.8	CITS Self-Test	2	505	0.72
9.9	CITS Display Control	2	1340	1.72
9.10	CITS Printer Control	2	1530	1.40
9.11	CITS Recorder Control	2	2015	1.76
	Total		18,541	66.56

Table A-28. CITS Function Detail Processing Requirements (Sheet 1 of 3)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
9.1	AMUX Validity Test							
	4 @ 64				40	64	2.56	
	16 @ 32				160	32	5.12	
	92 @ 16				920	16	14.72	
	2 @ 8				20	8	1.60	
	2 @ 4				20	4	0.80	
	140 @ 2				1400	2	2.80	
	5 @ 1				50	1	0.05	
	Task Total	-	70	261			27.65	*
9.2	Non-Avionics Tert-Fast							
	1. Continuous Test							
	2. Initiated Test							
	Task Total	1.9	1000	100	800	16	12.80	*
9.3	Non-Avionics Test-Slow							
	1. Continuous Test							
	2. Initiated Test							
	Task Total	1.12	5000	1000	4000	2	8.0	*
9.4	Avionics Test-Fast							
	1. Continuous Test							
	2. Initiated Test							
	Task Total	7.3	350	15	280	16	4.48	*
9.5	Avionics Test-Slow							
	1. Navigation							
	2. Steering							
	3. Target/Checkpoint Acquisition							
	4. Weapon Delivery							

Table A-28. CITS Function Detail Processing Requirements (Sheet 2 of 3)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
9.5 (Cont)	Avionics Test-Slow 5. Penetration Aids 6. Terrain Following 7. Mission Data Management 8. Mission and Traffic Control 9. CITS (Self-Test) 10. Executive							
	Task Total	7.5	2700	195	2160	2	4.43	*
9.6	Fault Isolation 1. On-Line Allocation							
	Task Total	9.8	2000	200	1600	2	3.2	*
9.7	Mode Selection 1. Manually Initiated Test							
	Task Total	7.5	250	10	200	2	0.4	*
9.8	CITS Self-Test 1. DAU Status 2. CITS Peripherals Status 3. CITS Program Status							
	Task Total	9.5	450	55	360	2	0.72	*
9.9	CITS Display Control 1. Master Caution 2. Status Panel Formatting 3. Maintenance Panel Formatting 4. Status Legends							
	Task Total	9.8	1075	265	860	2	1.72	*

Table A-28. CITS Function Detail Processing Requirements (Sheet 3 of 3)

Task	Title/Description	Pre-Req	Instr	Data	OPS/IT	IT/Sec	KOPS/Sec	W_c
9.10	CITS Printer Control							
	1. Status Monitor Print							
	2. Fault Detect Print							
	3. Printer Control Logic							
	4. Status ID Table							
	Task Total	9.9	650	880	520	2	1.40	*
9.11	CITS Recorder Control							
	1. Status and Monitor Record							
	2. Fault Isolation Record							
	3. Recorder Control Logic							
	4. Event Monitoring							
	5. Parameter Formatting							
	6. Data Address Table							
	Task Total	9.10	1100	915	880	2	1.76	*
	Function Total		14645	3896			66.56	

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13. ABSTRACT

An advanced manned bomber avionics system was used as the baseline avionics system to provide the computational requirements for the avionics processor controller study. This volume contains the detailed processing requirements of the major computational function. This report is also being published as Auton etics internal report C72-812/201.

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