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FLIGHT SOFTWARE MEMORY SIZING

AND CPU LOADING ESTIMATES

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SPACE SHUTTLE ORBITER AVIONICS SOFTWARE

FLIGHT SOFTWARE

MEMORY SIZING AND CPU LOADING ESTIMATES

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INTRODUCTION AND COMMENTS

This document summarizes the AP101 memory and CPU requirements for the Space Shuttle Orbiter. The resource estimates reflect OASCAB approved change requests for Release 18 and Release 19. Memory Sizes are presented in 32 bit full words, CPU loading is listed by percentage. Memory and CPU information was obtained from actual AP101 code where available, and from estimates provided by FSW development programmers. References 1 and 2 contain a detailed breakdown of the AP101 resource utilization.

* Page 3 summarizes projected Release 18 and Release 19 memory requirements for each memory configuration by major areas within the flight software. The bottom line totals reflect OASCB approved change requests through April 1980.

* Pages 4 and 5 project the amount of memory to be utilized in AP101 memory data sectors 0 and 1 for Releases 18 and 19. Adequate margin (400 FWDS) remains for Release 18. Release 19 SM2 and SM4 memory size projections are gradually being reduced as part of a continuing effort to offload this data to other sectors.

* The history information presented on pages 6 and 8 represents the estimated size and CPU utilization of the approved software requirements as they were understood at the time of the estimates. Memory sizes and CPU loadings for Releases 16 and 17 can be found here. Reference the February, 1980 issue of this document for history information prior to September 1979.

* Page 7 summarizes the current measured and projected CPU utilization for each major mode. The projections include all change requests approved through April 1980.

* The projected CPU utilization for major modes G202, G304, G305, G801, S201, S202, and S401 is currently above the level "A" CPDS guideline. This situation, however, is expected to be alleviated in the future by ongoing general CPU scrub activity.

* GN&C Rendezvous Navigation is a post release 19 capability. When implemented the following memory and CPU increases are projected:

GNC OPS 2	+ 4200 FWDS
GNC MM 201	+ 3%
GNC MM 202	+ 4%
GNC MM 801	+ 3%

* The S2 Release 18 memory projection reflects payload support for one SSUS and an IUS. The CPU projection reflects the more costly (+7%) SSUS payload. For release 19 the S2 memory projections reflect payload support for 3 SSUS's and OSTA while the CPU represents the 3 SSUS/3 Payload mission. The release 19 S4 projections are for 2 Spacelab computers. The S2/S4 memory projections include a 1200 word "SM Table Pad" to minimize the impact of mission reconfiguration data updates.

SPACE SHUTTLE MEMORY SUMMARY BY AREA (FWDS) (1)

MEMORY CONFIGURATION MAJOR FUNCTION(S) OPS('S) PHASE/FUNCTION	1 GN&C G1, G6 ASCENT, ABORTS	2 GN&C G2 ON-ORBIT	3 GN&C G3 ENTRY, LANDING	4 SM S2 ORB-DOORS	5 SM S4 ORBIT-PYLDS	6 VC P9 MM UTILITY	7 VC S9 INIT & CHECKOUT	8 VC G8 ON-ORBIT CHECKOUT	9 VC G9 PRECOUNT
FCOS	15365/15584	15223/15442	15263/15482	15388/15467	N/A/15402	16315/17702	16162/17515	15263/15482	16395/17762
USER INTERFACE	10282/10476	11121/11315	10769/10963	12680/12876	N/A/12872	11122/11316	11122/11316	11121/11315	11121/11315
SYSTEM CONTROL	6695/ 6716	36/9757	6695/6716	9736/ 9757	N/A/ 9757	10358/10379	9736/ 9757	9736/ 9757	9736/ 9757
MISC. & LIBRARY ROUTINES	5209/ 4379	4886/ 4421	5193/ 4783	4677/ 3877	N/A/ 3877	4189/ 4389	4277/ 3477	4811/ 4261	4695/ 4420
GN&C	63297/63102	46274/46846	59576/59957	94/ 94	N/A/ 93	457/ 457	457/ 457	32213/32301	17005/17006
VEHICLE C/O	2584/ 2584	2500/ 2500	2500/ 2500	9666/ 9221	N/A/ 9221	26514/27659	28635/29626	7631/ 8421	21857/23452
SM (AND DOWNLIST)	2306/ 2326	1719/ 2069	2370/ 2395	40752/45893	N/A/43171	1501/ 1501	2053/ 2053	1902/ 2112	2424/ 3194
REL.18/REL.19 TOTALS	105738/105167	91459/ 92350	102366/ 102796	92993/ 97183	N/A/94393	70456/ 73403	72442/ 74201	82677/83649	83233/86926

(1) Numbers in each column reflect Projected totals for Release 18 and Release 19 respectively.

PROJECTED MEMORY REQUIREMENTS FOR SECTORS 0 AND 1 - RELEASE 18

ITEM	GNC 1 MC1	GNC 2 MC2	GNC 3 MC3	SM2 MC4	SM4 MC5	PL9 MC6	SM9 MC7	GNC 8 MC8	GNC 9 MC9
Total Data* 4/29/80 Baseline, FWDS	34386	34317	35382	45915	N/A	37882	30356	32271	34354
Code Items Off-loaded to Data Sector	0	0	0	0	N/A	0	0	0	0
Data Items Off-loaded to Remote Sectors									
o System Level DFT's	302	302	302	302	N/A	302	302	302	302
o App. Level DFT's	1428	5011	2344	8124	N/A	3130	4535	5474	3997
o DEU Err. Messages (CDK Compool)	351	351	351	351	N/A	351	351	351	351
o Dsply. Roll-in Buffers - CDG154, CDH155				1542	N/A				
o Compools - CDI				1542	N/A	8710			
- CDS		327	327	327	N/A	327	327	327	327
- SM				3033	N/A				
SUBTOTAL -	2081	5991	3324	15221	N/A	12820	5515	6454	4977
Total Data Reqmts. for Sectors 0 & 1* Max = 32768	32305	28326	32058	30694	N/A	25062	24841	25817	29377

*Includes 1232 FWDS of Patch Areas

PROJECTED MEMORY REQUIREMENTS FOR SECTORS 0 AND 1 - RELEASE 19

ITEM	GNC 1 MC1	GNC 2 MC2	GNC 3 MC3	SM2 MC4	SM4 MC5	PL9 MC6	SM9 MC7	GNC 8 MC8	GNC 9 MC9
Total Data* 4/29/80 Baseline, FWDS	33328	34105	35110	47500	47783	38817	31477	32388	36036
Code Items Off-loaded to Data Sector	0	0	0	0	0	0	0	0	0
Data Items Off-loaded to Remote Sectors									
o System Level DFT's	302	302	302	302	302	302	302	302	302
o App. Level DFT's	1431	5011	2344	6291	6825	2524	4535	5474	3997
o DEU Err. Messages (CDK Compool)	351	351	351	351	351	351	351	351	351
o Dsply. Roll-in Buffers - CDG154, CDH155				1542	1542				
o Compools - CDI				1542	1542	8710			
- CDS		327	327	327	327	327	327	327	327
- SM				3033	3033				
SUBTOTAL -	2084	5991	3324	13388	13932	12214	5515	6454	4977
Total Data Reqmts. for Sectors 0 & 1* Max = 32768	31244	28114	31786	34112	33861	26603	25962	25934	31059

*Includes 1232 FWDS of Patch Areas

ORBITER MEMORY HISTORY (FWDS)

	DATE	MEM. CONF. 1 ASC., ABORT MEMORY	MEM. CONF. 2 ON-ORBIT MEMORY	MEM. CONF. 3 ENTRY, LAND. MEMORY	MEM. CONF. 4 ORBIT/DOORS MEMORY	MEM. CONF. 5 ORBIT/PAYLDS. MEMORY	MEM. CONF. 6 VU IM UTIL. MEMORY	MEM. CONF. 7 VU INIT & CO MEMORY	MEM. CONF. 8 VU ON-ORBIT CO MEMORY	MEM. CONF. 9 VC PRECOUNT MEMORY
R16V3 ACTUAL	SEP 1979	105240	83070 (1)	101120	84080	N/A	70120	72430	80320	81410
RELEASE 17	NOV 1979	105800	83000 (1)	102100	86684	N/A	70600	72441	79966	81568
POST RELEASE 17	NOV 1979	108000	98700	104300	108528	N/A	70695	72536	87022	81779
R17V5 ACTUAL	FEB 1980	105170	82630 (1)	101570	88800	N/A	70570	72500	80110	81720
RELEASE 18	FEB 1980	105060	89580	101290	TBD	N/A	70400	72330	82950	81880
RELEASE 19	FEB 1980	104080	94920	101450	TBD	TBD	70160	71700	84620	81770
RELEASE 18	MAY 1980	105738	91459	102366	92993	N/A	70456	72442	82677	83233
RELEASE 19	MAY 1980	105167	92350 (2)	102796	97183	94393	73403	74201	83649	86926

(1) DOES NOT INCLUDE "OPS 2 DEFERRAL" ITEMS
(2) DOES NOT INCLUDE RENDEZVOUS NAVIGATION

CPU UTILIZATION SUMMARY BY OPS/MAJOR MODE

G101	G102	G103	G104	G105	G1C6	G601	G602	G603T	G603A	G201	G202	G801	G301	G302	G303	G304	G305T	G305A	S201	S202	S401	
LAUNCH	1 STG	2 STG	OMS 1	OMS 2	COAST	PRTLS	GRTLS	TAEM	LAND	ORBIT	ORBIT ADJUST	ORBIT CHKOUT	COAST	DEORB	COAST	ENTRY	TAEM	LAND	ORB. OPER.	PL BAY DOOR/ SSUS	PL OP. SPACE-LAB	RMS AUTO/ MAN (5)
R16V3 PROJECTED (1)																						
66	66	62	51	51	48	67	68	69	69	65	N/A	74	59	57	52	70	70	72	45	46	N/A	N/A
R17V5 MEASUREMENTS																						
67	67	62	52	51	48	68	66	69	68	65	N/A	72	61	57	53	70	70	71	49	50	N/A	36/N/A
REL. 18 PROJECTED																						
69	68	63	57	54	51	68	70	70	71	68	73	75	63	60	56	72	72	74	49	57 (3)	N/A	35/34
REL. 19 PROJECTED																				(2)	(4)	
69	69	63	58	55	51	69	70	70	71	69	74	76	64	61	56	73	73	75	49	70/73	77/81	35/34

(1) ACTUAL R16V3 (PATCH SET 1) MEASUREMENT ADJUSTED TO REFLECT OPERATIONAL ENVIRONMENT AND INCLUDE PATCH SETS 2,3,4,5
(2) REL 19, 20 REPRESENTS A 3 SSUS ENVIRONMENT IN A NOMINAL/HIGH NOMINAL ENVIRONMENT
(3) REL 18 REPRESENTS A 1 SSUS ENVIRONMENT
(4) REL 19, 20 REPRESENT SPACELAB PAYLOAD IN A NOMINAL/HIGH NOMINAL ENVIRONMENT
(5) IF RMS (AUTO OR MANUAL) IS ACTIVE, THE SPECIFIED CPU SHOULD BE ADDED TO THE APPLICABLE S2 OR S4 MAJOR MODE PERCENTAGE

ORBITER CPU HISTORY (%)

ESTIMATES/MEASUREMENTS	ASCENT						RTLS				ORBIT			ENTRY						SM			
	101	102	103	104	105	106	601	602	603 TAEM	603 A/L	201*	202*	801	301	302	303	304	305 TAEM	305 A/L	201	202	401	RMS
EST. FULL CAP. (08/17/79)	62	66	57	47	47	44	68	66	67	64	70	77	75	55	53	48	67	67	69	75(2)			
EST. REL. 16 (11/15/79)	61	65	59	48	48	45	68	67	68	65	64(1)	N/A	73(1)	57	56	50	69	68	69	75(2)			
EST. REL. 17 (11/15/79)	64	68	59	48	48	45	69	67	68	65	64(1)	N/A	73(1)	58	56	51	72	71	71	75(2)			
EST. FULL CAP. (11/15/79)	64	68	60	50	50	47	70	67	68	65	74	80	82	59	58	52	72	71	72	75(2)			
MSRMT - FSW 16.3 (12/15/79)	64	64	60	49	49	46	66	66	67	67	63(1)	N/A	72(1)	58	55	50	68	68	70	43			N/A
EST. REL. 17 (2/80)	67	68	64	53	53	49	69	69	71	71	65(1)	N/A	73(1)	61	58	53	73	73	73	49			34
EST. FULL CAP. (2/80)	68	69	64	57	55	51	70	72	71	72	70	76	78	63	61	55	74	74	75	TBD			TBD
MSRMT - FSW 17.5 (3/13/80)	67	67	62	52	51	48	68	66	69	68	65(1)	N/A	72(1)	61	57	53	70	70	71	49	50	N/A	36
EST. REL 18 (4/80)	69	68	63	57	54	51	68	70	70	71	68	73	75	63	60	56	72	72	74	49	57(7)	N/A	35/34(3)
EST. REL 19 (4/80)	69	69	63	58	55	51	69	70	70	71	69(6)	74(6)	76(6)	64	61	56	73	73	75	49	70/73(4)	(5)	35/34(3)

(1) Does not include On-Orbit Nav Capability
(2) Includes RMS
(3) RMS in Auto Mode/Manual Mode
(4) 3 SSUS environment in Nominal/High Nominal
(5) Spacelab Payload Environment in Nominal/High Nominal
(6) Does Not Include Rendezvous Navigation
(7) 1 SSUS Environment

REFERENCES

1. IBM Flight Software Memory Data Base, April 29, 1980

2. IBM Memo, "OFT CPU Estimates, Version 2.05" by H. O. Davis, Dated January 10, 1980