SUBJECT: Additional USB Communications Coverage Provided by an Apollo Instrumentation Ship West of South America for Mission AS 204. Case 320

DATE: October 20, 1966

FROM: J. P. Maloy

ABSTRACT

The attached study examines the effect of stationing a ship west of South America at 118°W; 25°S in order to increase the USB communications coverage for Apollo mission AS 204. The results of the study show that a ship at that location, would eliminate all gaps in the USB communications coverage that exceed 101 minutes in duration.

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MEMORANDUM FOR FILE

Introduction

A study was made to determine the additional USB communications coverage that would be provided for Apollo mission AS-204 by stationing a ship west of South America at 118°W; 25°S. A coverage analysis was made of the 14 day mission for a launch azimuth of 72° assuming coverage from an elevation angle of 0° at the ground stations and a constant altitude of 105 nm for the spacevehicle. The data presented does not include irregularities in the coverage caused by local masking, antenna "keyhole" effects, or ship orientation. In addition to the ship, eight USB stations expected to be used during AS 204, were included in the study namely: Bermuda (BDA), Ascension (ASC), Carnarvon (CRO), Guam (GWM), Texas (TEX), and Cape Kennedy (MILA).

Observations

Table I indicates the gaps in USB coverage greater than 120 minutes that would exist without the ship. There would be 21 of these - 14 exceeding 3 hours and 7 lasting more than 4 hours but less than five. With the ship in position, the maximum gap is about 101 minutes. Table 1 shows the stations, revolutions, and gaps that are involved.

Figures 1 thru 5 give the USB contacts for the entire mission. The check mark indicates that the contact made by that station for that revolution is equal to or greater than three minutes in duration. Where a contact is less than three minutes the amount is indicated in these figures. (When one of these exists at the beginning or ending of a gap exceeding 120 minutes it is specified by an asterisk in Table 1.)

The large gaps in coverage are shown in Figures 1 thru 5 by the shaded areas. It should be noted that these shaded areas appear about every 15 revolutions. It should be noted too, that when the ship is deployed, at least one contact per revolution for the entire mission can be provided by two combinations of only three stations, namely the ship, HAW, and MILA and the ship, HAW, and CRO.

Another ship location was examined 4° further south (118°W; 29°S as specified in the AS 204 PSRD). This location also eliminated all coverage intervals of greater than 120 minutes but did not provide coverage on six revolutions of the 214 revolutions in the mission that the more northerly ship location did.

The effectiveness of any one station in reducing the number of long intervals between contacts can be seen by examining figures 1 thru 5. Ascension for example does not eliminate any of the long gaps but does reduce the size of these gaps in six cases by approximately 40 minutes. (See Table I)

A similar study based on MSC data showed that the interval between USB contacts (excluding ASC) exceeded 120 minutes 28 times. This was based on contacts 3 minutes at 5° elevation. The MSC mission was planned at >72° launch azimuth into a 85 - 130 nm elliptical orbit for approximately one day and then circularizing at 130 nm for the remainder of the 14 day mission.

Conclusions

An Apollo USB ship located off the west coast of South America at 118°W; 25°S would make it possible to provide USB contact on each revolution of a 14 day orbital mission like AS 204.

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2021-JPM-jad

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Attachments
Table 1
Appendix I

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TABLE 1

Gaps in USB Communications Coverage for 14 Day Mission

Launch Az = 72°; Elev = 0°; Alt = 105 n.m.

Gap >120 Minutes

	Stations	Revolution Numbers	Without Ship	Max Gap (Minutes) With Ship at 118°W; 25°S
1.	GWM - CRO	11-13	181.9*	87.0
2.	GWM - CRO	26-28	181.5	86.9
3.	GWM - CRO	41-43	181.3	86.8
4.	GWM - CRO	56-58	181.4	86.7
5.	GWM - CRO	71-73	182.0*	86.6
6.	HAW - GWM	82-84	169.2	87.9
	HAW - ASC	" "	130.9	"
7.	GWM - CRO	85-88	272.0	87.5
8.	HAW - GWM	97-99	169.2	87.4
	HAW - ASC	" "	127.9	"
9.	GWM - CRO	100-103	271.9	87.5
10.	HAW - GWM	112-114	169.8	87.1
	HAW - ASC	" "	127.8	"
11.	GWM - CRO	115-118	271.8	87.4
12.	HAW - GWM	127-129	169.2	86.8
	HAW - ASC	" "	127.8	"
13.	GWM - CRO	130-133	261.7	87.3
14.	HAW - GWM	142-144	169.2	86.6
	HAW - ASC	" "	127.8	"
15.	GWM - CRO	145-148	271.8	87.3
16.	HAW - GWM	157-159	169.3	86.6
	HAW - ASC	" "	127.9	"
17.	GWM - CRO	160-163	271.8	87.2
18.	HAW - GWM	171-173	170.8*	101.2
19.	GWM - CRO	175-178	271.8	87.1
20.	GWM - BDA	190-193	229.8*	87.0
21.	GWM - CRO	205-207	181.6*	86.9

*Indicates a gap that has a contact of < 3 min at the start or the end of the interval.

MISSION AS 201. USB COVERAGE

LAUNCH AZ = 72°; ELEV = 8°; ALT = 105 NM.

REVOLUTION	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
USB STATIONS															
BDA	✓	✓	✓											1.9	✓
ASC			✓	✓					0.9	✓	✓				
CRO	✓	✓	✓										1.4	✓	✓
GWM				✓	✓				✓	✓	✓				
HAW		✓	✓	✓	✓	✓	✓	✓							
(118W; 25S) SHIP								✓	✓	✓	✓		✓		
GYM	✓	✓	✓	✓	✓										✓
TEX	✓	✓	✓	✓	✓										✓
MILA	✓	✓	✓	✓										✓	✓

REVOLUTION	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
BDA	✓	✓	✓											✓	✓
ASC			✓	✓					26	✓	✓				
CRO	✓	✓	✓	✓									✓	✓	✓
GWM				✓	✓				✓	✓	✓				
HAW		✓	✓	✓	✓	✓	✓	✓							
(118W; 25S) SHIP								✓	✓	✓			✓		
GYM	✓	✓	✓	✓	✓										
TEX	✓	✓	✓	✓	✓									1.8	✓
MILA	✓	✓	✓	✓										✓	✓

REVOLUTION	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
BDA	✓	✓	✓											✓	✓
ASC			✓	✓					✓	✓	✓				
CRO	✓	✓	✓	✓									✓	✓	✓
GWM				✓	✓				✓	✓	✓				
HAW		✓	✓	✓	✓	✓	✓	✓							
(118W; 25S) SHIP								✓	✓	✓			✓		
GYM	✓	✓	✓	✓	✓										✓
TEX	✓	✓	✓	✓	2.5									✓	✓
MILA	✓	✓	✓	✓										✓	✓

LEGEND:

- ▒ GAP IN COVERAGE WITHOUT SHIP
- ✓ INDICATES COVERAGE ≥ 3 MINUTES

FIGURE 1

MISSION AS204 USB COVERAGE

LAUNCH AZ = 72°; ELEV = 0°; ALT = 105 NM.

REVOLUTION	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
USB STATIONS															
BDA	✓	✓	✓											✓	✓
ASC			✓	✓					✓	✓	1.9				
CRO	✓	✓	✓	✓									✓	✓	✓
GWM				✓	✓				✓	✓	✓				
HAW		✓	✓	✓	✓	✓	✓	✓							
(118°W; 25°S) SHIP								✓	✓	✓	✓		✓		
GYM	✓	✓	✓	✓	✓										✓
TEX	✓	✓	✓	✓										✓	✓
MILA	✓	✓	✓	✓										✓	✓

REVOLUTION	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
BDA	✓	✓	2.9											✓	✓
ASC			✓	✓					✓	✓					
CRO	✓	✓	✓	✓									✓	✓	✓
GWM				✓	✓				✓	✓	1.6				
HAW		✓	✓	✓	✓	✓	✓	2.0							
(118°W; 25°S) SHIP							✓	✓	1.0	✓			✓		
GYM	✓	✓	✓	✓	✓										✓
TEX	✓	✓	✓	✓										✓	✓
MILA	✓	✓	✓	✓										✓	✓

REVOLUTION	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
BDA	✓	✓	1.5											✓	✓
ASC			✓	✓					✓	✓					
CRO	✓	✓	✓	✓									✓	✓	✓
GWM				✓	✓				✓	✓					
HAW		✓	✓	✓	✓	✓	✓								
(118°W, 25°S) SHIP							✓	✓	✓	✓	✓	✓	✓		
GYM	✓	✓	✓	✓	✓										✓
TEX	✓	✓	✓	✓										✓	✓
MILA	✓	✓	✓	1.6										1.9	✓

LEGEND:

✓ } COVERAGE ≥ 3 MIN

▒ } GAP WITHOUT SHIP

FIGURE 2

MISSION AS 204 USB COVERAGE

LAUNCH AZ = 72°; ELEV = 8°; ALT = 105 NM

REVOLUTION	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
VERB STATIONS															
BDA	✓	✓												✓	✓
ASC			✓	✓					✓	✓					
CRO	✓	✓	✓	2.5									✓	✓	✓
GWM			2.6	✓	✓				✓	✓					
HAW		✓	✓	✓	✓	✓	✓								
(118°W; 25°S) SHIP							✓		✓				✓		
GYM	✓	✓	✓	✓	✓										✓
TEX	✓	✓	✓	✓										✓	✓
MILA	✓	✓	✓											✓	✓

REVOLUTION	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
BDA	✓	✓												✓	✓
ASC			✓	✓					✓	✓					
CRO	✓	✓	✓										✓	✓	✓
GWM			✓	✓	✓				✓	✓					
HAW	2.3	✓	✓	✓	✓	✓	✓								
(118°W; 25°S) SHIP							✓		✓				✓		
GYM	✓	✓	✓	✓	✓										✓
TEX	✓	✓	✓	✓										✓	✓
MILA	✓	✓	✓										✓	✓	✓

REVOLUTION	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135
BDA	✓	✓												✓	✓
ASC			✓	✓					✓	✓					
CRO	✓	✓	✓										✓	✓	✓
GWM			✓	✓	✓				✓	✓					
HAW	✓	✓	✓	✓	✓	✓	✓								
(118°W; 25°S) SHIP							✓		✓				✓		
GYM	✓	✓	✓	✓	✓										✓
TEX	✓	✓	✓	✓										✓	✓
MILA	✓	✓	✓										✓	✓	✓

LEGEND: ✓ } COVERAGE ≥ 3 MIN ; shaded } GAP WITHOUT SHIP

FIGURE 3

A-116 (7-63)

MISSION AS204 USB COVERAGE

LAUNCH AZ = 72°; ELEV = 0°; ALT = 105 NM

REVOLUTION	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
USB STATIONS															
BDA	✓	✓												✓	✓
ASC		2.5	✓	✓					✓	✓					
CRO	✓	✓	✓										✓	✓	✓
GWM			✓	✓	✓				✓	✓					
HAW	✓	✓	✓	✓	✓	✓	✓								
(118W; 25S) SHIP							✓	✓	✓				✓		
GYM	✓	✓	✓	✓	2.6									2.4	✓
TEX	✓	✓	✓	✓										✓	✓
MILA	✓	✓	✓										✓	✓	✓

REVOLUTION	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165
BDA	✓	✓												✓	✓
ASC		✓	✓	✓					✓	✓					
CRO	✓	✓	✓										✓	✓	✓
GWM			✓	✓	2.8				✓	✓					
HAW	✓	✓	✓	✓	✓	✓	✓								
(118W; 25S) SHIP							✓		✓						
GYM	✓	✓	✓	✓										✓	✓
TEX	✓	✓	✓	✓										✓	✓
MILA	✓	✓	✓										✓	✓	✓

REVOLUTION	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
BDA	✓	✓												✓	✓
ASC		✓	✓	2.2					✓	✓					
CRO	✓	✓	✓										✓	✓	✓
GWM			✓	✓	1.7			1.9	✓	✓					
HAW	✓	✓	✓	✓	✓	✓									
(118W; 25S) SHIP							✓	✓	✓						
GYM	✓	✓	✓	✓										✓	✓
TEX	✓	✓	✓	✓										✓	✓
MILA	✓	✓	✓										✓	✓	✓

LEGEND: ✓ } COVERAGE ≥ 3 MIN ; gap } GAP WITHOUT SHIP

FIGURE 4

A-116 (7-63)

MISSION AS 204 USB COVERAGE

LAUNCH AZ = 72°; ELEV = 0°; ALT = 105 NM

REVOLUTION	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195
USB STATIONS															
BDA	✓	✓											1.1	✓	✓
ASC		✓	✓						✓	✓					
CRO	✓	✓	✓										✓	✓	✓
GWM			✓	✓				2.1	✓	✓					
HAW	✓	✓	✓	✓	✓	✓	✓								
(118°W; 25°S) SHIP							✓	✓	✓						
GYM	✓	✓	✓	✓										✓	✓
TEX	✓	✓	✓	✓										✓	✓
MILA	✓	✓	✓										✓	✓	✓

REVOLUTION	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210
BDA	✓	✓											2.7	✓	✓
ASC		✓	✓					2.1	✓	✓					
CRO	✓	✓	✓									2.5	✓	✓	✓
GWM			✓	✓				✓	✓	✓					
HAW	✓	✓	✓	✓	✓	✓	✓								
(118°W; 25°S) SHIP							✓	✓	✓			✓			
GYM	✓	✓	✓	✓										✓	✓
TEX	✓	✓	✓	✓									0.7	✓	✓
MILA	✓	✓	✓										✓	✓	✓

REVOLUTION	211	212	213	214
BDA	✓	✓		
ASC		✓	✓	
CRO	✓	✓	✓	
GWM			✓	✓
HAW	✓	✓	✓	✓
(118°W; 25°S) SHIP	✓			
GYM	✓	✓	✓	✓
TEX	✓	✓	✓	✓
MILA	✓	✓	✓	

LEGEND: ✓ } COVERAGE ≥ 3 MIN ▒ } GAP WITHOUT SHIP

FIGURE 5