

MCR-70-38
(APPENDIX A)

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APPENDIX A
TO
FINAL REPORT
FOR
FORMULATION
OF A
TELEMETRY COMPUTER PROGRAM
CONTRACT NAS8-24017

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FINAL REPORT

For

FORMULATION OF A TELEMETRY COMPUTER PROGRAM

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Replace the FOREWORD, Page ii with the attached
FOREWORD, Page ii.

FOREWORD

This Final Report is presented in response to paragraph III.2 of Exhibit A of Contract NAS 8-24017. It consists of two volumes, MCR-70-38 and MCR-70-38, Appendix A.

APPENDIX A

EXAMPLE OFFORMAT AND ADDRESS EQUATION GENERATION BY COMPUTER

The purpose of this appendix is to give an example of the operation of the algorithm. The data input is shown in Table A-1.

TABLE A-1: INPUT

CLOCK - 16 WORDS PER FRAME
8 FRAMES PER MASTER FRAME

TYPE	MODE A		MODE B		MODE C	
	NO. CH.	S/MF	NO. CH.	S/MF	NO. CH.	S/MF
SYNC	3	8	3	8	3	8
RW	1	1	1	1	1	1
A1	2	8	2	8	2	8
A2	2	8	-	-	-	-
A3	5	4	5	4	5	4
A4	2	4	2	4	-	-
A5	-	-	2	4	-	-
B1	16	2	16	2	16	2
B2	-	-	4	2	4	2
B3	-	-	-	-	10	2
B4	6	1	6	1	6	1
B5	4	1	4	1	-	-
PM	1	1	1	1	1	1

This data does not have any data groups where the samples per main frame changes from mode to mode (except to 0 in some cases), but the algorithm will process this kind of change.

First, the input data is prepared as follows. From the clock input data, the algorithm produces the allowable samples per main frame and the number of channels that are allowed per card at each rate. These are listed in Table A-2.

TABLE A-2: SAMPLE RATES AND CHANNELS PER CARD

ALLOWABLE SAMPLE RATES S/MF	ALLOWABLE CHANNELS PER CARD
16	1
8	1 2
4	1 2 4
2	1 2 4 8
1	1 2 4 8 16

Using the allowable channels per card as shown in Table A-2, the new set of cards listed in Table A-3 is generated.

TABLE A-3: NEW CARDS GENERATED

MODE A			MODE B		MODE C	
<u>TYPE</u>	<u>NO. CH.</u>	<u>S/MF</u>	<u>NO. CH.</u>	<u>S/MF</u>	<u>NO. CH.</u>	<u>S/MF</u>
SYNC 1	1	8	1	8	1	8
SYNC 2	1	8	1	8	1	8
SYNC 3	1	8	1	8	1	8
RW	1	1	1	1	1	1
A1	2	8	2	8	2	8
A2	2	8	0	0	0	0
A3a	4	4	4	4	4	4
A3b	1	4	1	4	1	4
A4	2	4	2	4	0	0
A5	0	0	2	4	0	0
B1a	8	2	8	2	8	2
B1b	8	2	8	2	8	2
B2	0	0	4	2	4	2
B3a	0	0	0	0	8	2
B3b	0	0	0	0	2	2
B4a	4	1	4	1	4	1
B4b	2	1	2	1	2	1
B5	4	1	4	1	0	0
PM	1	1	1	1	1	1

One of the checks made during card generation is whether the number of time slots required for binary data exceeds one-fourth of the total number of time slots available and, if so, the message "binaries are greater than 1/4 total time slots binary may follow binary" is printed. This is true for the example.

The algorithm then sorts the Mode A cards with RW and SYNC first, then in descending order of S/MF, and then in descending order of channels per card. The results of this sort is listed in Table A-4.

TABLE A-4: MODE A SORT

<u>TYPE</u>	<u>NO. CH.</u>	<u>S/MF</u>
SYNC 1	1	8
SYNC 2	1	8
SYNC 3	1	8
RW	1	1
A1	2	8
A2	2	8
A3a	4	4
A4	2	4
A3b	1	4
B1a	8	2
B1b	8	2
B4a	4	1
B5	4	1
B4b	2	1
PM	1	1

Figure A-1 shows the first attempt to assign Mode A. SYNC 1, 2 and 3 are assigned the last three words in each frame and RW is assigned the first word in the first frame. Then Group A1, two channels of analog data at 8 S/MF, is assigned.

		FRAME							
		0	1	2	3	4	5	6	7
WORD	0	RW							
	1					A2-2			
	2					B1a			
	3	8	6	4	2	8	6	4	2
	4					A1-2			
	5					A3a			
	6	4	2	4	2	4	2	4	2
	7					A3b			
	8					A4			
	9	2	1	2	1	2	1	2	1
	10					A2-1			
	11					B1a			
	12	7	5	3	1	7	5	3	1
	13					A1-1			
	14					A3a			
	15	3	1	3	1	3	1	3	1

A3a - 2nd

B1b - 2nd

A3a - 1st

B1b - 1st

A3a - 3rd

FIGURE A-1: MODE A ASSIGNMENT - FIRST ATTEMPT

For 8 S/MF there must be one sample per frame for each channel, the two channels should be 8 words apart and, as an analog channel, should be assigned to an odd number. Thus, A1 is assigned to words 11 and 3 for each frame. Similarly, A2, 2 analog channels at 8 S/MF, is assigned to words 9 and 1. Assignment of A3a, 4 of 4 S/MF, is first tried in every other frame, words 7 and 15, but 15 is assigned to SYNC 1; then for 5 and 13, but 13 is assigned to SYNC 3. Thus, A3a cannot be assigned to odd numbers so it tries even numbers, 12 and 4, which works. A4, 2 at 4 S/MF, is assigned to word 7 with each channel repeating every other frame. A3b, 1 at 4 S/MF is assigned every other frame in word 5. B1a, 8 binary channels at 2 S/MF, is then assigned to words 10 and 2 with each channel repeating every fourth frame. B1b, 8 at 2 S/MF, will not fit in words 8 and 0 because RW is assigned to word 0 in frame 1. B1b also cannot be assigned to 6 and 14 because of SYNC 2.

There are no other possibilities so the algorithm reduces the allowable number of channels per card, regenerates the cards and resorts them. The result is listed in Table A-5 and the resulting Mode A format assignment is made and is shown in Figure A-2.

TABLE A-5: MODE A RESORT

<u>TYPE</u>	<u>NO. CH.</u>	<u>S/MF</u>
SYNC 1	1	8
SYNC 2	1	8
SYNC 3	1	8
RW	1	1
A1	2	8
A2	2	8
A3a	4	4
A4	2	4
A3b	1	4
B1a1	4	2
B1a2	4	2
B1b1	4	2
B1b2	4	2
B4a	4	1
B5	4	1
B4b	2	1
P1	1	1

		<u>FRAME</u>							
		0	1	2	3	4	5	6	7
WORD	0		B4a	B4b	B4a	PM	B4a	B4b	B4a
	1	RW	4	2	3		2	i	1
	2				A2-2				
	3				B1b2				
	4	4	3	2	1	4	3	2	1
	5				A1-2				
	6				A3a				
	7	4	2	4	2	4	2	4	2
	8	B5	A3b	B5	A3b	B5	A3b	B5	A3b
	9	4		3		2		1	
	10				B1b1				
	11	4	3	2	1	4	3	2	1
	12				A4				
	13	2	1	2	1	2	1	2	1
	14				B1a2				
	15	4	3	2	1	4	3	2	1

FIGURE A-2: MODE A ASSIGNMENT - SECOND ATTEMPT

As the result of the assignment of B5, the error message "conflict in binary therefore a binary follows a binary" is printed.

For Mode B assignment, the Mode B cards are sorted as for Mode A except that the channels that are the same for Modes A and B are listed as transfers. Table A-5 shows the results.

TABLE A-5: MODE B SORT

<u>TRANSFER</u>		
<u>TYPE</u>	<u>NO. CH.</u>	<u>S/MF</u>
SYNC 1	1	8
SYNC 2	1	8
SYNC 3	1	8
RW	1	1
A1	2	8
A3a	4	4
A4	2	4
A3b	1	4
B1a1	4	2
B1a2	4	2
B1b1	4	2
B1b2	4	2
B4a	4	1
B5	4	1
B4b	2	1
PM	1	1
<u>SORT</u>		
A5	2	4
B2	4	2

Mode B is then assigned as shown in Figure A-3. The assignment of B2 results in requiring the binary follows binary message.

Mode C is assigned in a similar manner except that transfers from B to C will not be made if there is a conflict with A to C transfers. Table A-6 and Figure A-4 show the Mode C sort and assignment respectively.

		<u>FRAME</u>							
		0	1	2	3	4	5	6	7
WORD	0	RW	B4a 4	B4b 2	B4a 3	PM	B4a 2	B4b 1	B4a 1
	1	4	3	2	B2 1	4	3	2	1
	2	4	3	2	B1b2 1	4	3	2	1
	3	A1-2							
	4	A3a							
	5	4 B5	2 A3b	4 B5	2 A3b	4 B5	2 A3b	4 B5	2 A3b
	6	4	3	2	B1b1 1	4	3	2	1
	7	2	1	2	A4 1	2	1	2	1
	8	4	3	2	B1a2 1	4	3	2	1
	9	2	1	2	A5 1	2	1	2	1
	10	4	3	2	B1a1 1	4	3	2	1
	11	A1-1							
	12	A3a							
	13	3	1	3	1	3	1	3	1
	14	SYNC 3							
	15	SYNC 2							
		SYNC 1							

FIGURE A-3: MODE B ASSIGNMENT

TABLE A-6: MODE C SORT

TRANSFER A-C

<u>TYPE</u>	<u>NO. CH.</u>	<u>S/MF</u>
SYNC 1	1	8
SYNC 2	1	8
SYNC 3	1	8
RW	1	1
A1	2	8
A3a	4	4
A3b	1	4
B1a1	4	2
B1a2	4	2
B1b1	4	2
B1b2	4	2
B4a	4	1
B4b	2	1
PM	1	1

TRANSFER B-C

B2	4	2
----	---	---

SORT

B3a1	4	2
B3a2	4	2
B3b	2	2

		<u>FRAME</u>							
		0	1	2	3	4	5	6	7
WORD	0	RW	B4a 4	B4b 2	B4a 3	PM	B4a 2	B4b 1	B4a 1
	1	4	3	2	B2 1	4	3	2	1
	2	4	3	2	B1b2 1	4	3	2	1
	3				A1-2				
	4				A3a				
	5	B3b 2	A3b	B3b 1	A3b	B3b 2	A3b	B3b 1	A3b
	6	4	3	2	B1b1 1	4	3	2	1
	7	4	3	2	B3a2 1	4	3	2	1
	8	4	3	2	B1a2 1	4	3	2	1
	9	4	3	2	B3a1 1	4	3	2	1
	10	4	3	2	B1a1 1	4	3	2	1
	11				A1-1				
	12				A3a				
	13	3	1	3	1	3	1	3	1
	14				SYNC 3				
	15				SYNC 2				
					SYNC 1				

FIGURE A-4: MODE C ASSIGNMENT

Assignment of B3a1 results in the binary follows binary message.

Following the format generation, the cards are sorted by SYNC and then by the number of channels. Addresses are then assigned as shown in Figure A-5. Figure A-5 also shows the counter state for each card.

Figure A-6 shows the Mode A set equations generated by the algorithm.

					ADDRESS ASSIGNMENT										MODE A COUNTER STATE										
TYPE	NO.	CH.	S/MF	MODE	10	9	8	7	6	5	4	3	2	1	16-14	13	12	11	10-5	4	3	2	1		
SYNC 1	1		8	A,B,C	1	0	0	0	0	0	0	0	0	0		φ	φ	φ			1	1	1	1	
SYNC 2	1		8	A,B,C	1	0	0	0	0	0	0	0	0	0		φ	φ	φ			1	1	1	0	
SYNC 3	1		8	A,B,C	1	0	0	0	0	0	0	0	0	0		φ	φ	φ			1	1	0	1	
A3a	4		4	A,B,C	X	X	0	0	0	0	0	0	0	0	1		φ	φ	X		X	1	0	0	
B1a1	4		2	A,B,C	X	X	0	0	0	0	0	0	0	1	0		φ	X	X			1	0	1	0
B1a2	4		2	A,B,C	X	X	0	0	0	0	0	0	0	1	1		φ	X	X			1	0	0	0
B1b1	4		2	A,B,C	X	X	0	0	0	0	0	0	1	0	0		φ	X	X			0	1	1	0
B1b2	4		2	A,B,C	X	X	0	0	0	0	0	0	1	0	1		φ	X	X			0	0	1	0
B2	4		2	B,C	X	X	0	0	0	0	0	0	1	1	0			---					---		
B3a1	4		2	C	X	X	0	0	0	0	0	0	1	1	1	φ		---		φ			---		
B3a2	4		2	C	X	X	0	0	0	0	0	1	0	0	0			---					---		
B4a	4		1	A,B,C	X	X	0	0	0	0	0	1	0	0	1		X	X	1			0	0	0	0
B5	4		1	A,B	X	X	0	0	0	0	0	1	0	1	0		X	X	0			0	1	0	1
A1	2		8	A,B,C	X	0	0	0	0	0	0	1	0	1	1		φ	φ	φ			X	0	1	1
A2	2		8	A	X	0	0	0	0	0	0	1	1	0	0		φ	φ	φ			X	0	0	1
A4	2		4	A,B	X	0	0	0	0	0	0	1	1	0	1		φ	φ	X			0	1	1	1
A5	2		4	B	X	0	0	0	0	0	0	1	1	1	0			---					---		
B3b	2		2	C	X	0	0	0	0	0	0	1	1	1	1			---					---		
B4b	2		1	A,B,C	X	0	0	0	0	0	1	0	0	0	0		X	1	0			0	0	0	0
A3b	1		4	A,B,C	0	C	0	0	0	0	1	0	0	0	1		φ	φ	1			0	1	0	1
RW	1		1	A,B,C	0	0	0	0	0	0	1	0	0	1	0		0	0	0			0	0	0	0
PM	1		1	A,B,C	0	0	0	0	0	0	1	0	0	1	1		1	0	0			0	0	0	0

FIGURE A-5: ADDRESS AND MODE A STATE GENERATION

$$\begin{aligned}
s1 &= \overline{Q1} \cdot \overline{Q2} \cdot Q3 + \overline{Q1} \cdot \overline{Q2} \cdot \overline{Q3} \cdot Q4 + \overline{Q1} \cdot Q2 \cdot \overline{Q3} \cdot \overline{Q4} + \overline{Q1} \cdot \overline{Q2} \cdot \overline{Q3} \cdot \overline{Q4} \cdot Q11 + Q1 \cdot Q2 \cdot \overline{Q3} + Q1 \cdot Q2 \cdot Q3 \cdot \overline{Q4} + Q1 \cdot \overline{Q2} \cdot Q3 \cdot \overline{Q4} \cdot Q11 \\
&\quad + \overline{Q1} \cdot \overline{Q2} \cdot \overline{Q3} \cdot \overline{Q4} \cdot \overline{Q11} \cdot \overline{Q12} \cdot Q13 \\
s2 &= \overline{Q1} \cdot Q2 \cdot \overline{Q3} \cdot Q4 + \overline{Q1} \cdot \overline{Q2} \cdot \overline{Q3} \cdot Q4 + Q1 \cdot \overline{Q2} \cdot Q3 \cdot \overline{Q4} \cdot \overline{Q11} + Q1 \cdot Q2 \cdot \overline{Q3} + \overline{Q1} \cdot \overline{Q2} \cdot \overline{Q3} \cdot \overline{Q4} \cdot \overline{Q11} \cdot \overline{Q12} \cdot \overline{Q13} \\
&\quad + \overline{Q1} \cdot \overline{Q2} \cdot \overline{Q3} \cdot \overline{Q4} \cdot \overline{Q11} \cdot \overline{Q12} \cdot Q13 \\
s3 &= \overline{Q1} \cdot Q2 \cdot Q3 \cdot \overline{Q4} + \overline{Q1} \cdot Q2 \cdot \overline{Q3} \cdot \overline{Q4} + Q1 \cdot \overline{Q2} \cdot \overline{Q3} + Q1 \cdot Q2 \cdot Q3 \cdot \overline{Q4} \\
s4 &= \overline{Q1} \cdot \overline{Q2} \cdot \overline{Q3} \cdot \overline{Q4} \cdot Q11 + Q1 \cdot \overline{Q2} \cdot Q3 \cdot \overline{Q4} \cdot \overline{Q11} + Q1 \cdot Q2 \cdot \overline{Q3} + Q1 \cdot \overline{Q2} \cdot \overline{Q3} + Q1 \cdot Q2 \cdot Q3 \cdot \overline{Q4} \\
s5 &= \overline{Q1} \cdot \overline{Q2} \cdot \overline{Q3} \cdot \overline{Q4} \cdot \overline{Q11} \cdot Q12 + Q1 \cdot \overline{Q2} \cdot Q3 \cdot \overline{Q4} \cdot Q11 + \overline{Q1} \cdot \overline{Q2} \cdot \overline{Q3} \cdot \overline{Q4} \cdot \overline{Q11} \cdot \overline{Q12} \cdot \overline{Q13} + \overline{Q1} \cdot \overline{Q2} \cdot \overline{Q3} \cdot \overline{Q4} \cdot \overline{Q11} \cdot \overline{Q12} \cdot Q13 \\
s6 &= 0 \\
s7 &= 0 \\
s8 &= 0 \\
s9 &= \overline{Q1} \cdot \overline{Q2} \cdot Q3 \cdot Q4 + \overline{Q1} \cdot Q2 \cdot \overline{Q3} \cdot Q4 \cdot Q11 + \overline{Q1} \cdot \overline{Q2} \cdot \overline{Q3} \cdot Q4 \cdot Q11 + \overline{Q1} \cdot Q2 \cdot Q3 \cdot \overline{Q4} \cdot Q11 + \overline{Q1} \cdot Q2 \cdot \overline{Q3} \cdot \overline{Q4} \cdot Q11 \\
&\quad + \overline{Q1} \cdot \overline{Q2} \cdot \overline{Q3} \cdot \overline{Q4} \cdot Q11 \cdot Q12 + Q1 \cdot \overline{Q2} \cdot Q3 \cdot \overline{Q4} \cdot \overline{Q11} \cdot Q12 \\
s10 &= Q1 \cdot Q2 \cdot Q3 \cdot Q4 + \overline{Q1} \cdot Q2 \cdot Q3 \cdot Q4 + Q1 \cdot \overline{Q2} \cdot Q3 \cdot Q4 + \overline{Q1} \cdot \overline{Q2} \cdot Q3 \cdot Q11 + \overline{Q1} \cdot Q2 \cdot \overline{Q3} \cdot Q4 \cdot Q12 + \overline{Q1} \cdot \overline{Q2} \cdot \overline{Q3} \cdot Q4 \cdot Q12 + \\
&\quad + \overline{Q1} \cdot Q2 \cdot Q3 \cdot \overline{Q4} \cdot Q12 + \overline{Q1} \cdot Q2 \cdot \overline{Q3} \cdot \overline{Q4} \cdot Q12 + \overline{Q1} \cdot \overline{Q2} \cdot \overline{Q3} \cdot \overline{Q4} \cdot Q11 \cdot Q13 + Q1 \cdot \overline{Q2} \cdot Q3 \cdot \overline{Q4} \cdot \overline{Q11} \cdot Q13 + Q1 \cdot Q2 \cdot \overline{Q3} \cdot \overline{Q4} \\
&\quad + Q1 \cdot \overline{Q2} \cdot \overline{Q3} \cdot Q4 + Q1 \cdot Q2 \cdot Q3 \cdot \overline{Q4} \cdot Q11 + \overline{Q1} \cdot \overline{Q2} \cdot \overline{Q3} \cdot \overline{Q4} \cdot \overline{Q11} \cdot Q12 \cdot Q13
\end{aligned}$$

FIGURE A-6: MODE A EQUATIONS