

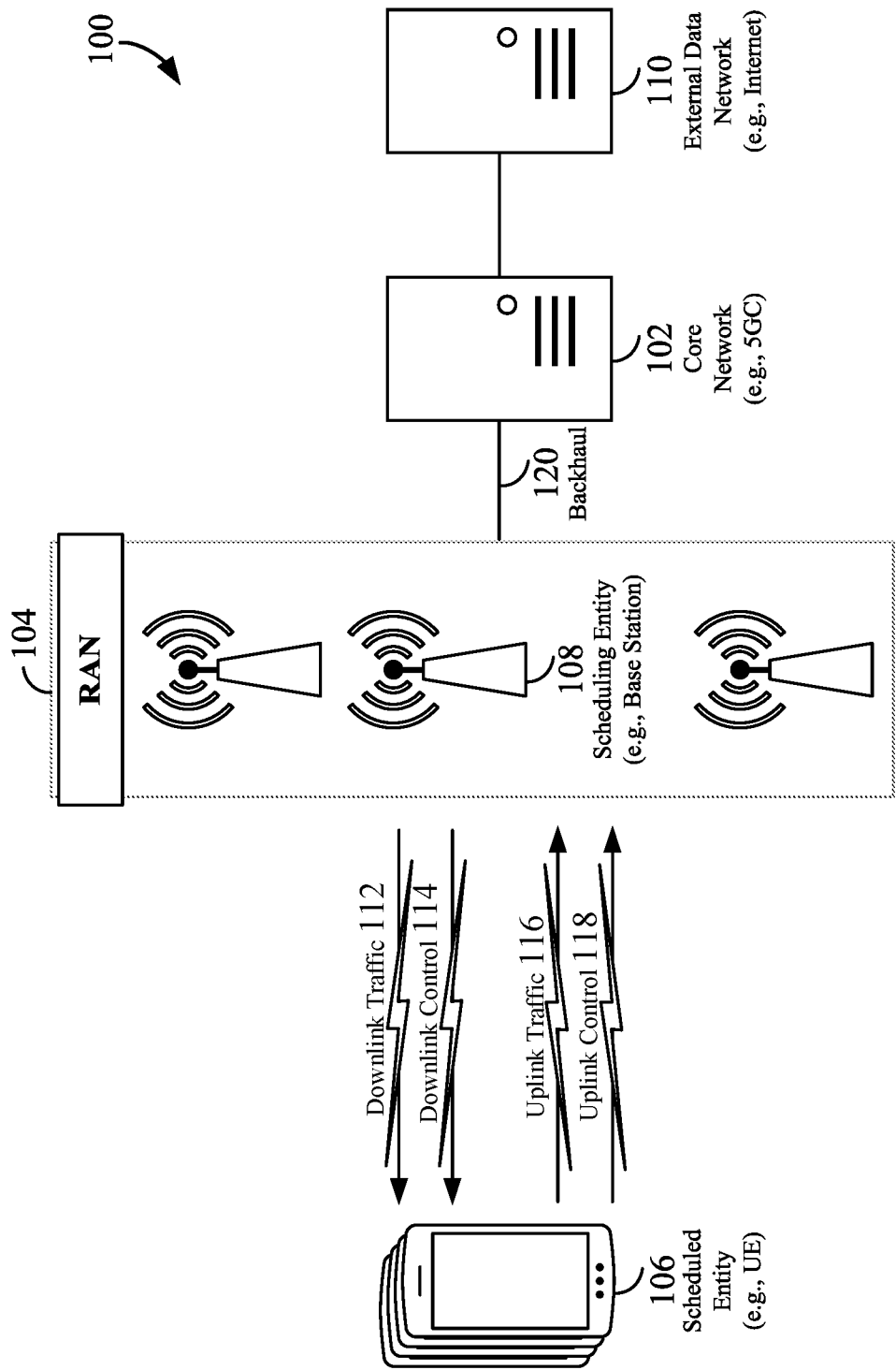


FIG. 1

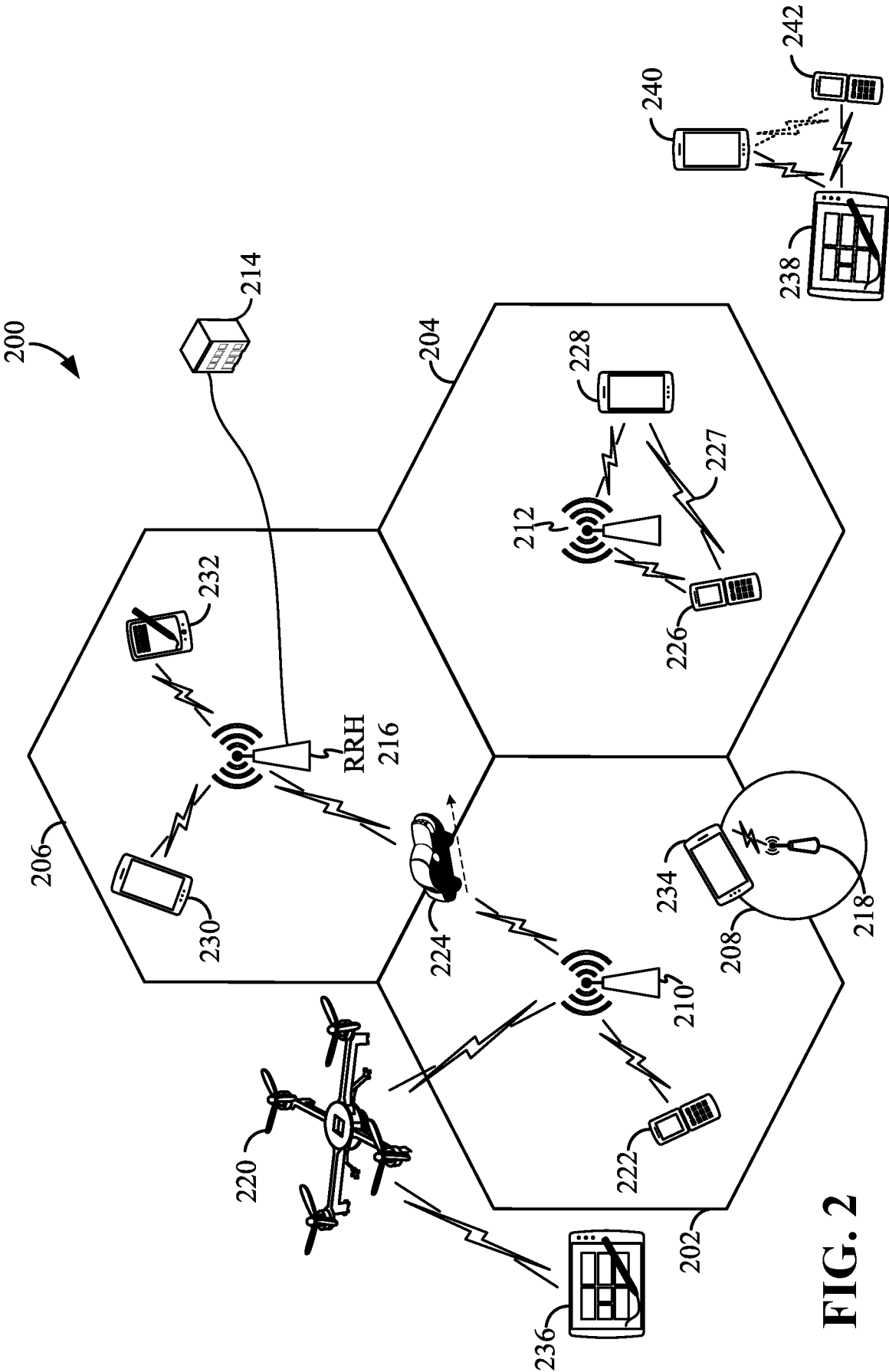


FIG. 2

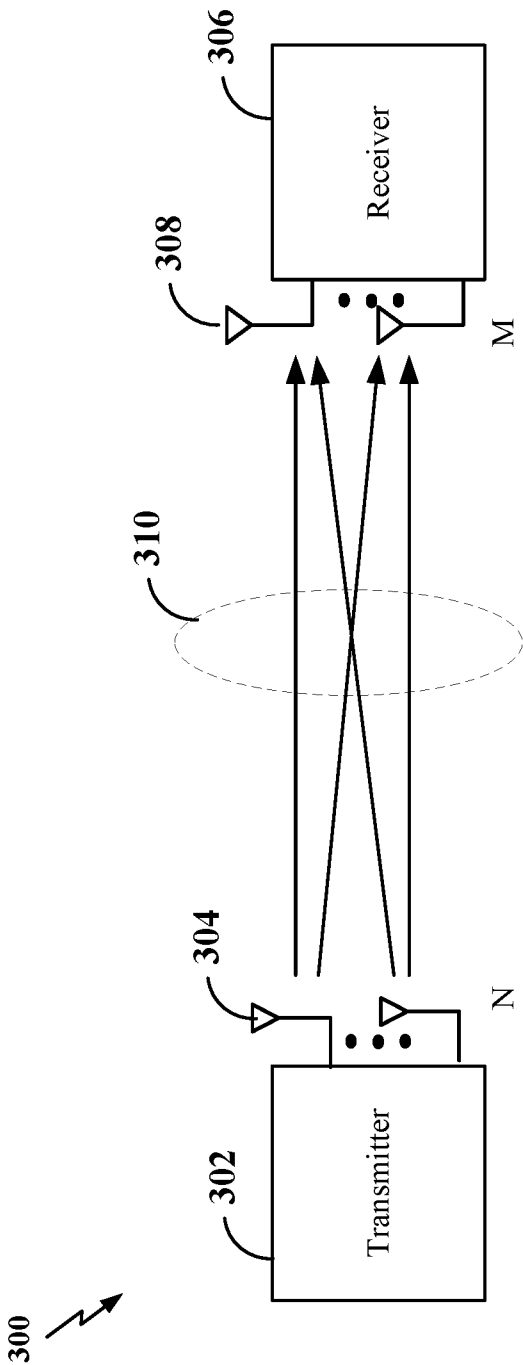


FIG. 3

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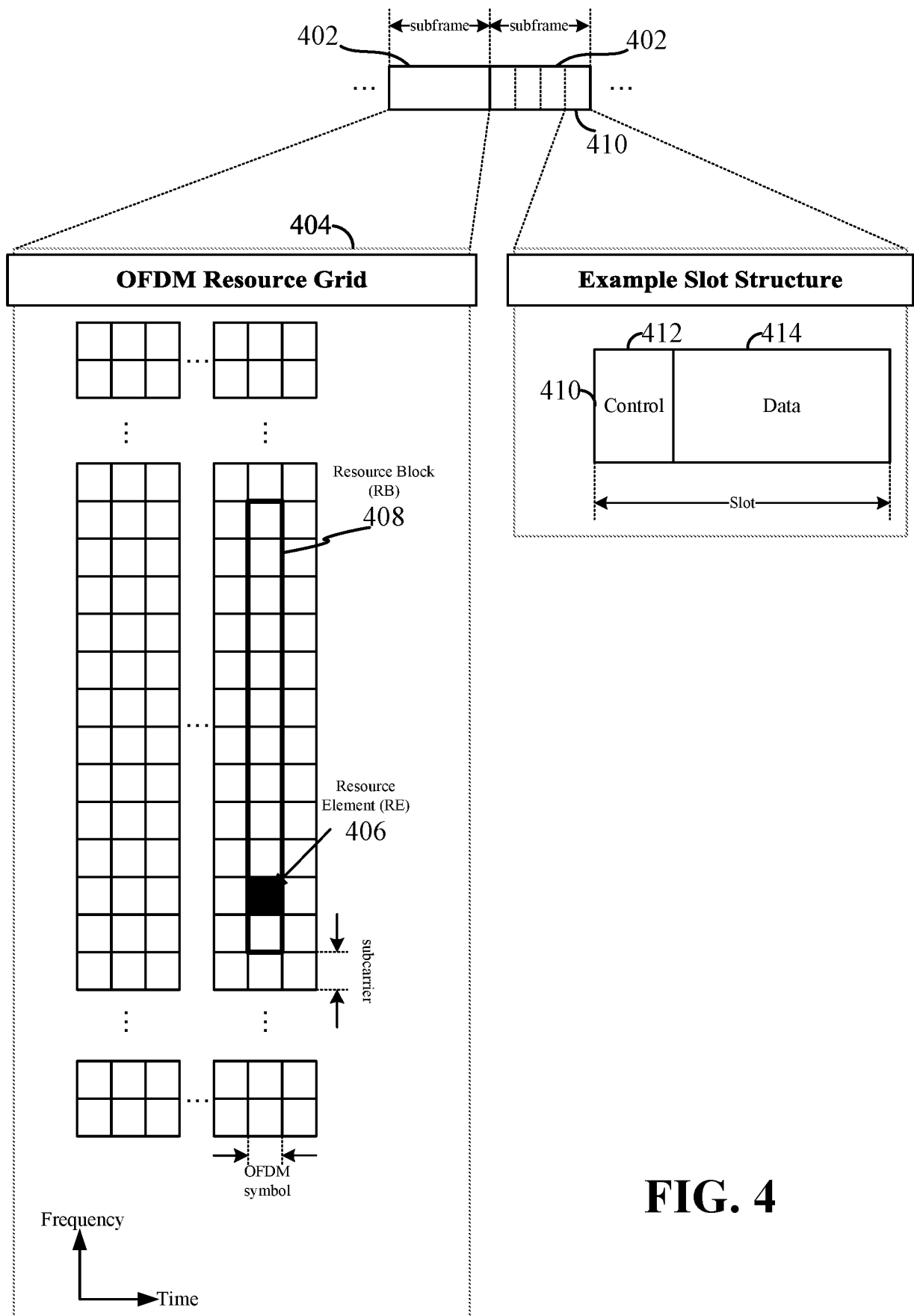


FIG. 4

FIG. 5

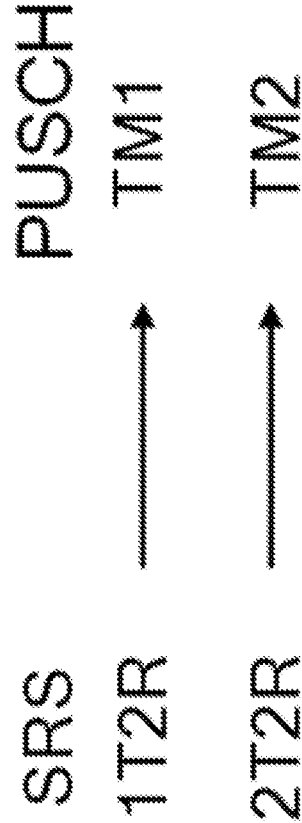
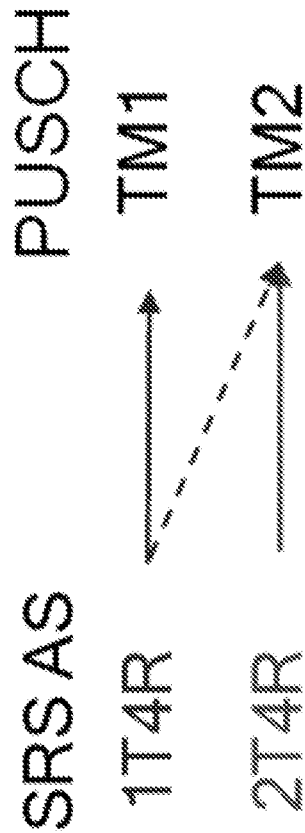


FIG. 6



SRS 1T2R with Frequency Hopping on
K = Four Sub-bands

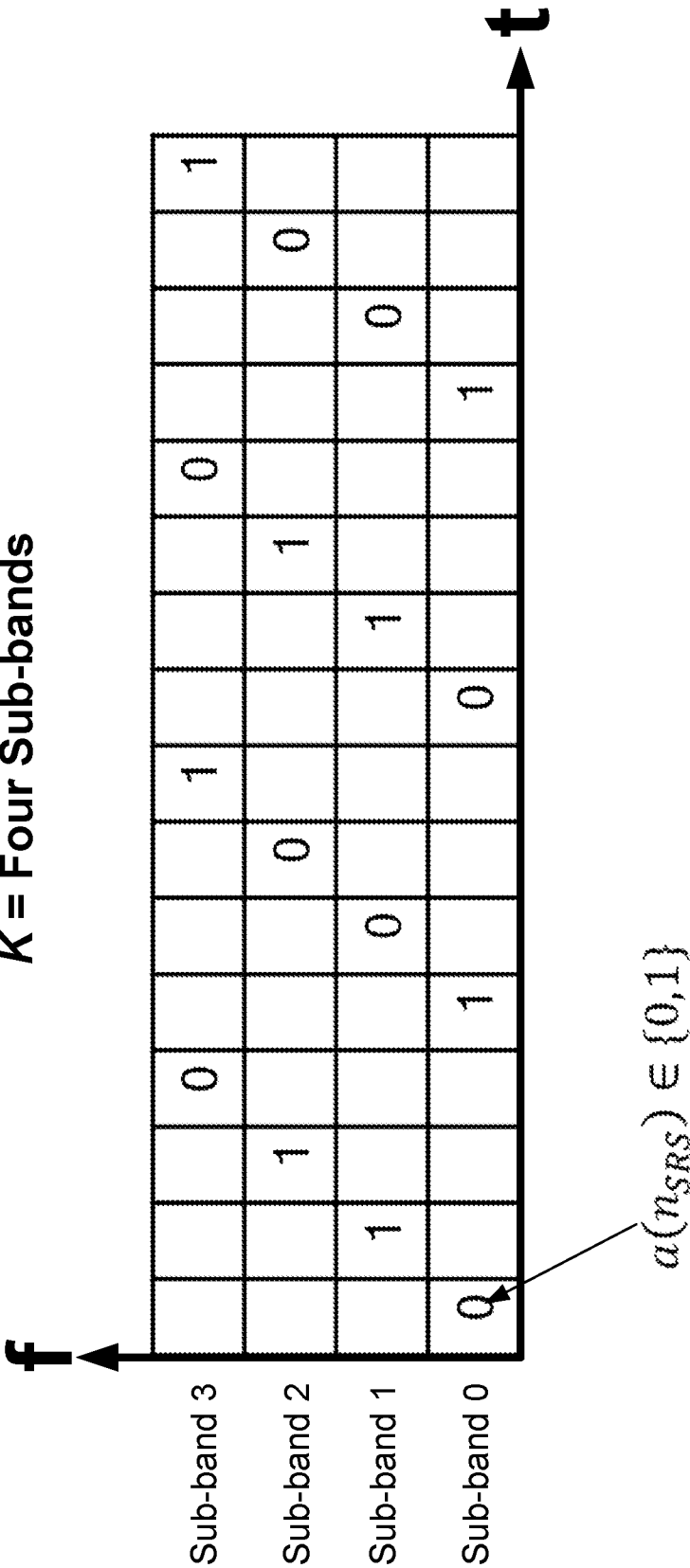


FIG. 7

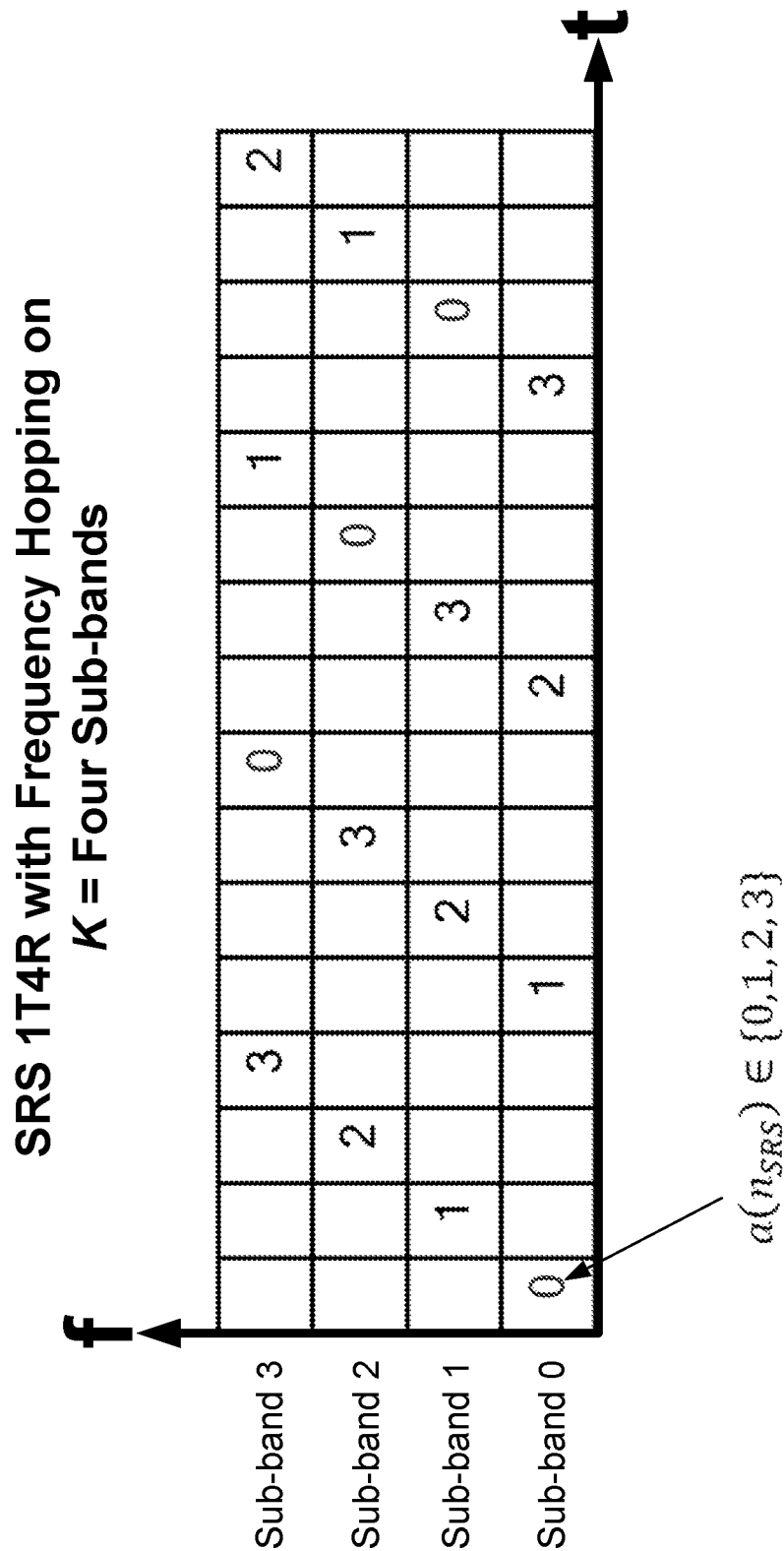


FIG. 8

FIG. 9

K=4	start			
n_srs	0	1	2	3
0	0			
1			1	
2		2		
3				3
4	1			
5			2	
6		3		
7				0
8	2			
9			3	
10		0		
11				1
12	3			
13			0	
14		1		
15				2

FIG. 10

K=4	n_srs	start	1	2	3
	0	pair0			
	1			pair1	
	2		pair0		
	3				pair1
	4	pair1			
	5			pair0	
	6		pair1		
	7				pair0

SRS 2T4R with no Frequency Hopping
($\Lambda_p = 6$ antenna pairs)

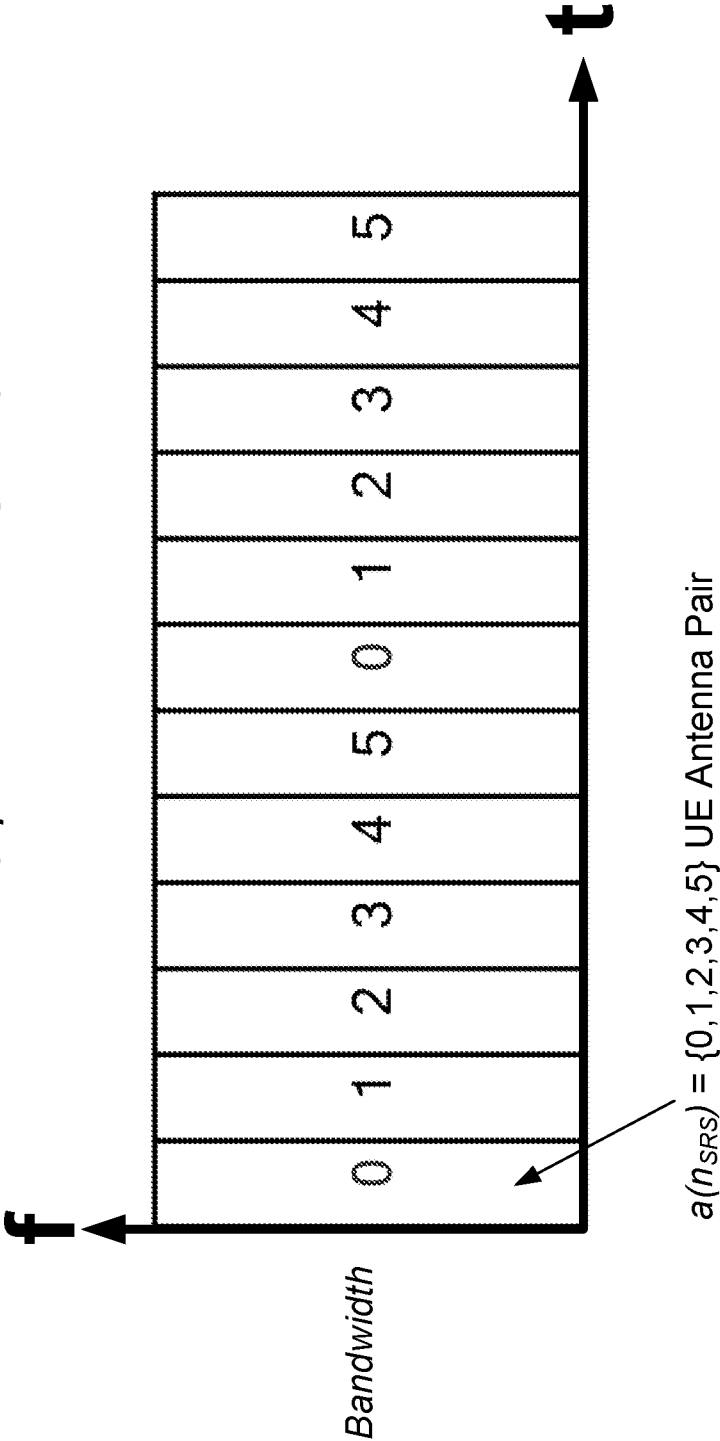


FIG. 12

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n	m	1/4 BW			1/4 BW			1/4 BW			1/4 BW		
		0	1	2	3	4	5	6	7	8	9	10	11
0	0	0											
1	1							1					
2	2				2								
3	3										3		
4	0		0										
5	1							1					
6	2					2							
7	3											3	
8	0			0									
9	1									1			
10	2						2						
11	3												3
12	1	1											
13	2							2					
14	3				3								
15	0										0		
16	1		1										
17	2								2				
18	3					3							
19	0											0	
20	1			1									
21	2									2			
22	3						3						
23	0												0
24	2	2											
25	3							3					
26	0				0								
27	1										1		
28	2		2										
29	3								3				
30	0					0							
31	1											1	
32	2			2									
33	3									3			
34	0						0						
35	1												1
36	2	3											
37	0							0					
38	1				1								
39	2										2		
40	3		3										
41	0								0				
42	1					1							
43	2											2	
44	3			3									
45	0									0			
46	1						1						
47	2												2

FIG. 13

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n	m	1/4 BW			1/4 BW			1/4 BW			1/4 BW		
		0	1	2	3	4	5	6	7	8	9	10	11
0	0	0											
1	1							1					
2	2				2								
3	3										3		
4	1		1										
5	2								2				
6	3					3							
7	0											0	
8	2			2									
9	1									3			
10	0						0						
11	1												1
12	0	0											
13	1							1					
14	2				2								
15	3										3		
16	1		1										
17	2								2				
18	3					3							
19	0											0	
20	2			2									
21	3									3			
22	0						0						
23	1												1
24	0	0											
25	1							1					
26	2				2								
27	3										3		
28	1		1										
29	2								2				
30	3					3							
31	0											0	
32	2			2									
33	3									3			
34	0						0						
35	1												1
36	0	0											
37	1							1					
38	2				2								
39	3										3		
40	1		1										
41	2								2				
42	3					3							
43	0											0	
44	2			2									
45	3									3			
46	0						0						
47	1												1

FIG. 14

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n	ans	1/4 BW			1/4 BW			1/4 BW			1/4 BW		
		0	1	2	3	4	5	6	7	8	9	10	11
0	0	0											
1	1							1					
2	2				2								
3	3										3		
4	1		1										
5	2								2				
6	3					3							
7	0											0	
8	2			2									
9	3									3			
10	0						0						
11	1												1
12	1	1											
13	2							2					
14	3				3								
15	0										0		
16	2		2										
17	3								3				
18	0					0							
19	1											1	
20	3			3									
21	0									0			
22	1						1						
23	2												2
24	2	2											
25	3							3					
26	0				0								
27	1											1	
28	3		3										
29	0								0				
30	1					1							
31	2											2	
32	0			0									
33	1									1			
34	2						2						
35	3												3
36	3	3											
37	0							0					
38	1				1								
39	2										2		
40	0		0										
41	1								1				
42	2					2							
43	3											3	
44	1			1									
45	2									2			
46	3						3						
47	0												0

FIG. 15

16/39

Q. NO.	SW/2	SW/3				SW/3				SW/3			
		0	1	2	3	4	5	6	7	8	9	10	11
0	0	0											
1	1					2							
2	2									2			
3	3			1									
4	0							0					
5	1											1	
6	2		2										
7	3						2						
8	0										0		
9	1				1								
10	2								2				
11	3												3
12	1	1											
13	2					2							
14	3									3			
15	0			0									
16	1							1					
17	2											2	
18	3		3										
19	0						0						
20	1											1	
21	2				2								
22	3								3				
23	0												0
24	1	1											
25	2					3							
26	3												
27	0			1									
28	1							1					
29	2											2	
30	3		0										
31	0						1						
32	1										2		
33	2				3								
34	3								0				
35	0												3
36	1	3											
37	2					0							
38	3									1			
39	0			2									
40	1							1					
41	2											0	
42	3	1											
43	0						2						
44	1										3		
45	2				0								
46	3								1				
47	0												2

FIG. 16

17/39

n	m	SW/3				SW/3				SW/3			
		0	1	2	3	4	5	6	7	8	9	10	11
0	0	0											
1	1					1							
2	2									2			
3	3			3									
4	1							1					
5	2											2	
6	3		3										
7	0						0						
8	2										2		
9	3				3								
10	0								0				
11	1												1
12	0	0											
13	1					1							
14	2									2			
15	3			3									
16	1							1					
17	2											2	
18	3		3										
19	0						0						
20	2										2		
21	3				3								
22	0								0				
23	1												1
24	0	0											
25	1					1							
26	2									2			
27	3			3									
28	1							1					
29	2											2	
30	3		3										
31	0						0						
32	2										2		
33	3				3								
34	0								0				
35	1												1
36	0	0											
37	1					1							
38	2									2			
39	3			3									
40	1							1					
41	2											2	
42	3		3										
43	0						0						
44	2										2		
45	3				3								
46	0								0				
47	1												1

FIG. 17

18/39

row	col	SW/3				SW/3				SW/3			
		0	1	2	3	4	5	6	7	8	9	10	11
0	0	0											
1	1					1							
2	2									2			
3	3			3									
4	1							1					
5	2											2	
6	3		3										
7	0						0						
8	2										2		
9	3				3								
10	0								0				
11	1												1
12	1	1											
13	2					2							
14	3									3			
15	0			0									
16	2							2					
17	3											3	
18	0		0										
19	1						1						
20	3										3		
21	0				0								
22	1								1				
23	2												2
24	2	2											
25	3					3							
26	0									0			
27	1			1									
28	3							3					
29	0												
30	1		1										
31	2						2						
32	0										0		
33	1				1								
34	2								2				
35	3												3
36	3	3											
37	0					0							
38	1									1			
39	2			2									
40	0							0					
41	1											1	
42	2		2										
43	3						3						
44	1										1		
45	2				2								
46	3								3				
47	0												0

FIG. 18

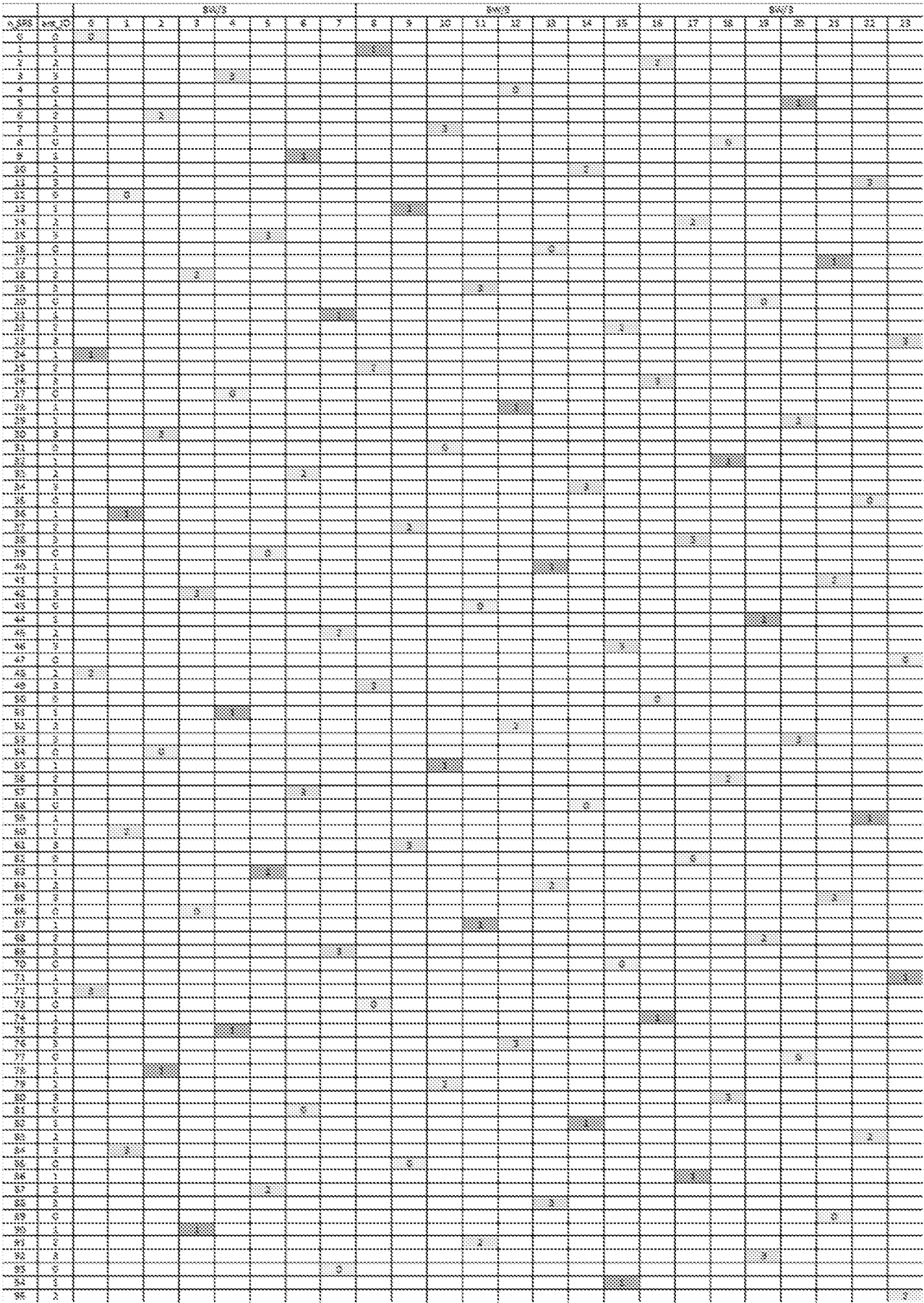


FIG. 19

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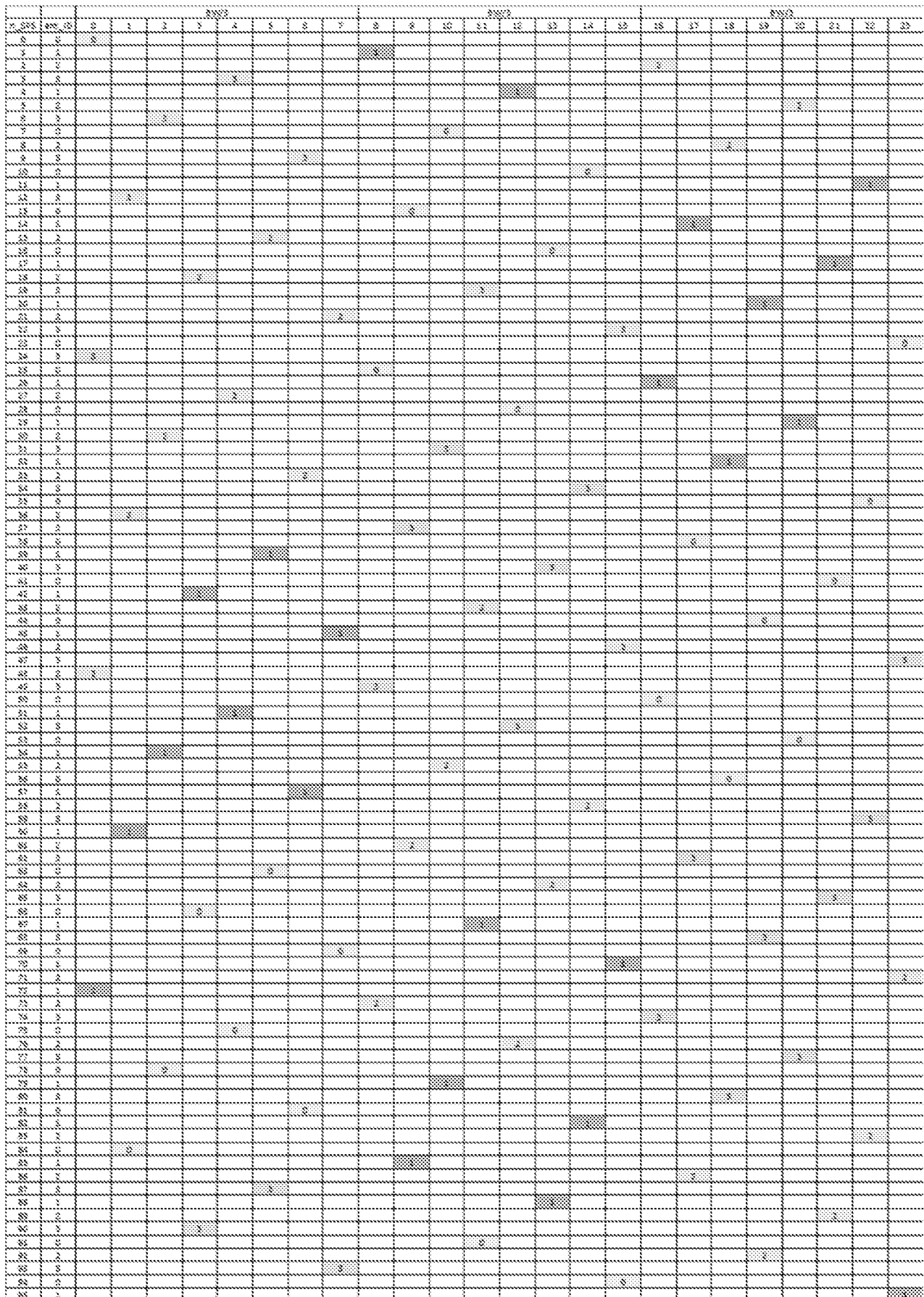


FIG. 20

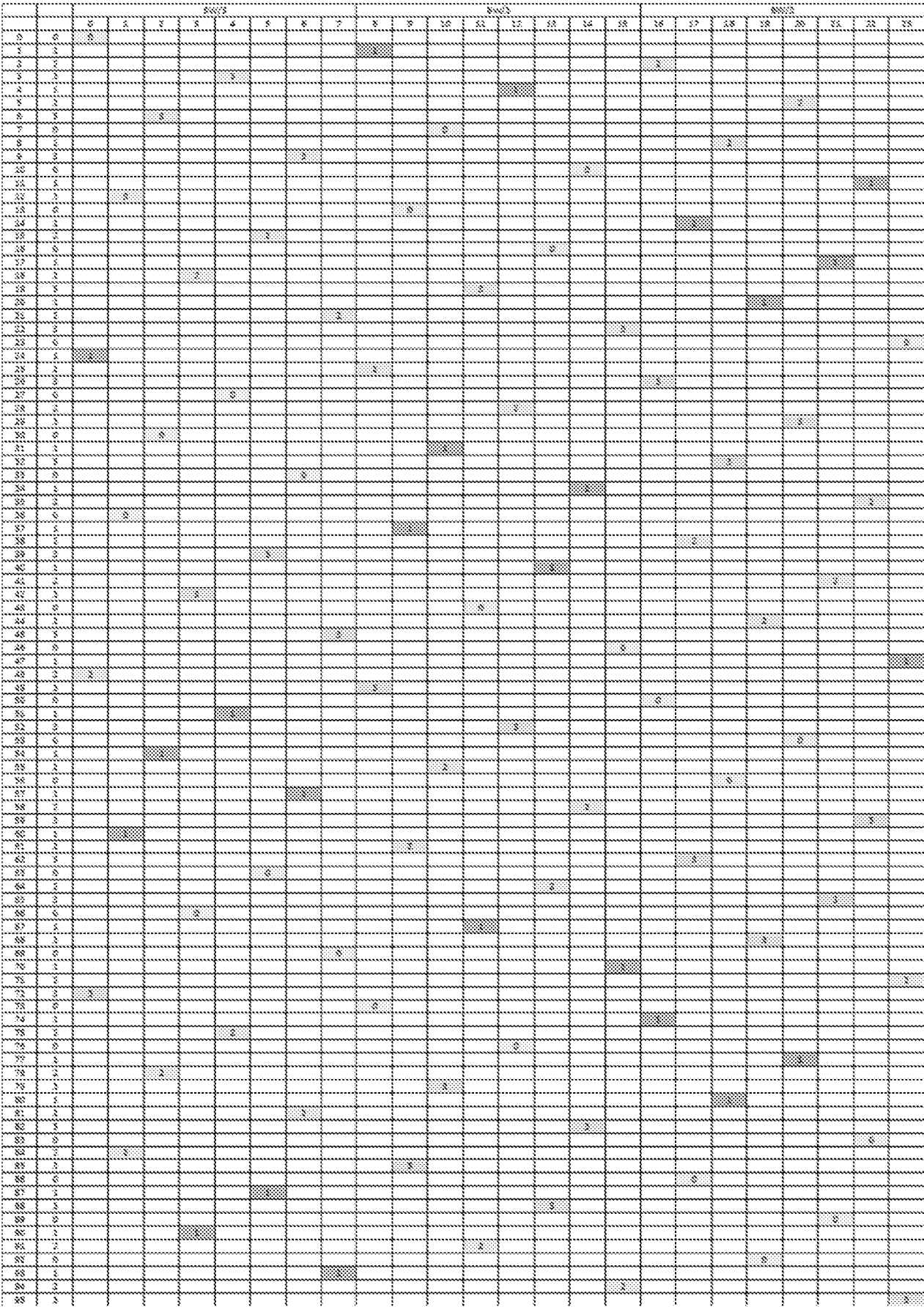


FIG. 21

22/39

		1/18887					1/18888					1/18889					1/18890				
1/18887	1/18888	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
1	1	0									1										
2	2																				
3	3																				
4	4			0																	
5	5																				
6	6																				
7	7																				
8	8																				
9	9																				
10	10																				
11	11																				
12	12																				
13	13																				
14	14																				
15	15																				
16	16																				
17	17																				
18	18																				
19	19																				
20	20																				
21	21																				
22	22																				
23	23																				
24	24																				
25	25																				
26	26																				
27	27																				
28	28																				
29	29																				
30	30																				
31	31																				
32	32																				
33	33																				
34	34																				
35	35																				
36	36																				
37	37																				
38	38																				
39	39																				
40	40																				
41	41																				
42	42																				
43	43																				
44	44																				
45	45																				
46	46																				
47	47																				
48	48																				
49	49																				
50	50																				
51	51																				
52	52																				
53	53																				
54	54																				
55	55																				
56	56																				
57	57																				
58	58																				
59	59																				
60	60																				
61	61																				
62	62																				
63	63																				
64	64																				
65	65																				
66	66																				
67	67																				
68	68																				
69	69																				
70	70																				
71	71																				
72	72																				
73	73																				
74	74																				
75	75																				
76	76																				
77	77																				
78	78																				
79	79																				
80	80																				

FIG. 22

23/39

5-25		1-4896					1-4897					1-4898					1-4899				
5-25	5-25	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
0	0	0																			
1	1																				
2	2																				
3	3																				
4	4																				
5	5																				
6	6																				
7	7																				
8	8																				
9	9																				
10	10																				
11	11																				
12	12																				
13	13																				
14	14																				
15	15																				
16	16																				
17	17																				
18	18																				
19	19																				
20	20																				
21	21																				
22	22																				
23	23																				
24	24																				
25	25																				
26	26																				
27	27																				
28	28																				
29	29																				
30	30																				
31	31																				
32	32																				
33	33																				
34	34																				
35	35																				
36	36																				
37	37																				
38	38																				
39	39																				
40	40																				
41	41																				
42	42																				
43	43																				
44	44																				
45	45																				
46	46																				
47	47																				
48	48																				
49	49																				
50	50																				
51	51																				
52	52																				
53	53																				
54	54																				
55	55																				
56	56																				
57	57																				
58	58																				
59	59																				
60	60																				
61	61																				
62	62																				
63	63																				
64	64																				
65	65																				
66	66																				
67	67																				
68	68																				
69	69																				
70	70																				
71	71																				
72	72																				
73	73																				
74	74																				
75	75																				
76	76																				
77	77																				
78	78																				
79	79																				

FIG. 23

24/39

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1	1																	
2	1	1																	
3	1	1																	
4	1	1																	
5	1	1																	
6	1	1																	
7	1	1																	
8	1	1																	
9	1	1																	
10	1	1																	
11	1	1																	
12	1	1																	
13	1	1																	
14	1	1																	
15	1	1																	
16	1	1																	
17	1	1																	
18	1	1																	
19	1	1																	
20	1	1																	
21	1	1																	
22	1	1																	
23	1	1																	
24	1	1																	
25	1	1																	
26	1	1																	
27	1	1																	
28	1	1																	
29	1	1																	
30	1	1																	
31	1	1																	
32	1	1																	
33	1	1																	
34	1	1																	
35	1	1																	
36	1	1																	
37	1	1																	
38	1	1																	
39	1	1																	
40	1	1																	
41	1	1																	
42	1	1																	
43	1	1																	
44	1	1																	
45	1	1																	
46	1	1																	
47	1	1																	
48	1	1																	
49	1	1																	
50	1	1																	
51	1	1																	
52	1	1																	
53	1	1																	
54	1	1																	
55	1	1																	
56	1	1																	
57	1	1																	
58	1	1																	
59	1	1																	
60	1	1																	
61	1	1																	
62	1	1																	
63	1	1																	
64	1	1																	
65	1	1																	
66	1	1																	
67	1	1																	
68	1	1																	
69	1	1																	
70	1	1																	
71	1	1																	
72	1	1																	
73	1	1																	
74	1	1																	
75	1	1																	
76	1	1																	
77	1	1																	
78	1	1																	
79	1	1																	

FIG. 24

25/39

K=8						start		
n_srs	f0	f1	f2	f3	f4	f5	f6	f7
0						0		
1		1						
2								2
3				3				
4					0			
5	1							
6							2	
7			3					
8						1		
9		2						
10								3
11				0				
12					1			
13	2							
14							3	
15			0					
16						2		
17		3						
18								0
19				1				
20					2			
21	3							
22							0	
23			1					
24						3		
25		0						
26								1
27				2				
28					3			
29	0							
30							1	
31			2					

FIG. 25

26/39

K=8						start		
n_srs	f0	f1	f2	f3	f4	f5	f6	f7
0						0		
1		1						
2								2
3				3				
4					1			
5	2							
6							3	
7			0					
8						3		
9		0						
10								1
11				2				
12					0			
13	1							
14							2	
15			3					
16						2		
17		3						
18								0
19				1				
20					3			
21	0							
22							1	
23			2					
24						1		
25		2						
26								3
27				0				
28					2			
29	3							
30							0	
31			1					

FIG. 26

27/39

n_SRS	ant_ID	f0	f1	f2	f3	f4	f5	f6	f7
0	0						0		
1	1		1						
2	2								2
3	3				3				
4	1					1			
5	2	2							
6	3							3	
7	0			0					
8	1						1		
9	2		2						
10	3								3
11	0				0				
12	2					2			
13	3	3							
14	0							0	
15	1			1					
16	2						2		
17	3		3						
18	0								0
19	1				1				
20	3					3			
21	0	0							
22	1							1	
23	2			2					
24	3						3		
25	0		0						
26	1								1
27	2				2				
28	0					0			
29	1	1							
30	2							2	
31	3			3					

FIG. 27

28/39

K=10						start				
n_sns	f0	f1	f2	f3	f4	f5	f6	f7	f8	f9
0						0				
1	1									
2								2		
3			3							
4										0
5					1					
6							2			
7		3								
8									0	
9				1						
10						3				
11	0									
12								1		
13			2							
14										3
15					0					
16							1			
17		2								
18									3	
19				0						
20						2				
21	3									
22								0		
23			1							
24										2
25					3					
26							0			
27		1								
28									2	
29				3						
30						1				
31	2									
32								3		
33			0							
34										1
35					2					
36							3			
37		0								
38									1	
39				2						

FIG. 28

FIG. 30

[illegible]

FIG. 31

K=8	f0	f1	f2	f3	f4	start	f6	f7
n_srs						f5		
0						0		
1		1						
2								0
3				1				
4					0			
5	1							
6							0	
7			1					
8						1		
9		0						
10								1
11				0				
12					1			
13	0							
14							1	
15			0					

FIG. 32

K=8	f0	f1	f2	f3	f4	start	f6	f7
n_srs								
0						0		
1		1						
2							1	
3				0				
4					0			
5	1							
6							1	
7			0					
8						1		
9		0						
10								0
11				1				
12					1			
13	0							
14							0	
15			1					

FIG. 33

	AP pair {0,1}			AP pair {2,3}		
Rank1	$\begin{bmatrix} 1 & 1 & 0 & 0 \end{bmatrix}$	$\begin{bmatrix} 1 & j & 0 & 0 \end{bmatrix}$	$\begin{bmatrix} 1 & -j & 0 & 0 \end{bmatrix}$	$\begin{bmatrix} 0 & 0 & 1 & 1 \end{bmatrix}$	$\begin{bmatrix} 0 & 0 & 1 & -j \end{bmatrix}$	$\begin{bmatrix} 0 & 0 & 1 & -1 \end{bmatrix}$
	$\begin{bmatrix} 1 & 0 & 0 & 0 \end{bmatrix}$	$\begin{bmatrix} 0 & 1 & 0 & 0 \end{bmatrix}$		$\begin{bmatrix} 0 & 0 & 1 & 0 \end{bmatrix}$		
Rank2	$\begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$			$\begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}$		

Alternative signaling: instead of signaling the codebook itself (e.g. 12 possibilities for R1, 2 for R2),

- Method 1: use 2x2 codebook + 1 bit RRC signaling to indicate the AP pair is {0,1} or {2,3}
- Method 2: use 2x2 codebook + LTE two DCI CRC masks to indicate the AP pair is {0,1} or {2,3}

Codebook for 2x2 MIMO (TS 36.211, Table 5.3.3A.2-1). Equivalences for the first two entries shown in both tables

Codebook Index	Number of layers	
	0, 1	0, 2
0	$\begin{bmatrix} 1 & 1 \\ \frac{1}{\sqrt{2}} & 1 \end{bmatrix}$	$\begin{bmatrix} 1 & 1 & 0 \\ \frac{1}{\sqrt{2}} & 0 & 1 \end{bmatrix}$
1	$\begin{bmatrix} 1 & 1 \\ \frac{1}{\sqrt{2}} & -1 \end{bmatrix}$	-
2	$\begin{bmatrix} 1 & 1 \\ \frac{1}{\sqrt{2}} & j \end{bmatrix}$	-
3	$\begin{bmatrix} 1 & 1 \\ \frac{1}{\sqrt{2}} & -j \end{bmatrix}$	-
4	$\begin{bmatrix} 1 & 1 \\ \frac{1}{\sqrt{2}} & 0 \end{bmatrix}$	-
5	$\begin{bmatrix} 1 & 0 \\ \frac{1}{\sqrt{2}} & 1 \end{bmatrix}$	-

FIG. 34

Rank1	$[1, 1, 0, 0]$	$[1, j, 0, 0]$	$[1, -j, 0, 0]$	$[1, -1, 0, 0]$				
	$[1, 0, 1, 0]$	$[1, 0, j, 0]$	$[1, 0, -j, 0]$	$[1, 0, -1, 0]$				
	$[1, 0, 0, 1]$	$[1, 0, 0, j]$	$[1, 0, 0, -j]$	$[1, 0, 0, -1]$				
	$[1, 0, 0, 0]$	$[0, 1, 0, 0]$			$[0, 0, 1, 0]$	$[0, 0, 0, 1]$		
Rank2	$\begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$	$\begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}$	$\begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 1 \\ 0 & 1 \end{bmatrix}$					

- The codebook can be extended with all possible combinations (new entries highlighted)
 - Alternatively, 2x2 codebook + 2-bit RRC signaling to indicate which AP pair is for PUSCH
- For all possible Rx antenna combinations, we can set $\Lambda_p=3$ antenna pairs for SRS 2T4R and the UE will sound all the K subbands.

FIG. 35

Rank1	[1,1,0,0]	[1,j,0,0]	[1,-j,0,0]	[1,-1,0,0]	[0,0,1,1]	[0,0,1,j]	[0,0,1,-j]	[0,0,1,-1]
	[1,0,1,0]	[1,0,j,0]	[1,0,-j,0]	[1,0,-j,0]	[0,1,0,1]	[0,1,0,j]	[0,1,0,-j]	[0,1,0,-1]
	[1,0,0,1]	[1,0,0,j]	[1,0,0,-j]	[1,0,0,-j]	[0,1,1,0]	[0,1,j,0]	[0,1,-j,0]	[0,1,-1,0]
	[1,0,0,0]	[0,1,0,0]			[0,0,1,0]	[0,0,0,1]		
Rank2	$\begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$	$\begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}$	$\begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}$		$\begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}$	$\begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}$	$\begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}$	

- The codebook can be extended with all possible combinations (new entries highlighted)
 - Alternatively, 2x2 codebook + 3-bit RRC signaling to indicate which AP pair is for PUSCH
- For all possible Rx antenna combinations, we can set $A_p=6$ antenna pairs for SRS 2T4R and the UE will sound all the K subbands.
 - UE-specific configuration with similar overhead of the total sounding length as $K \times A_p$.
 - For an edge UE with hopping on $K=3$ subbands, use $A_p=2$ to get sounding of pre-defined AP pairs (Opt2a).
 - For a center UEs with no hopping on only $K=1$ band, configure $A_p=6$ to get sounding of all AP pairs (Opt2b).

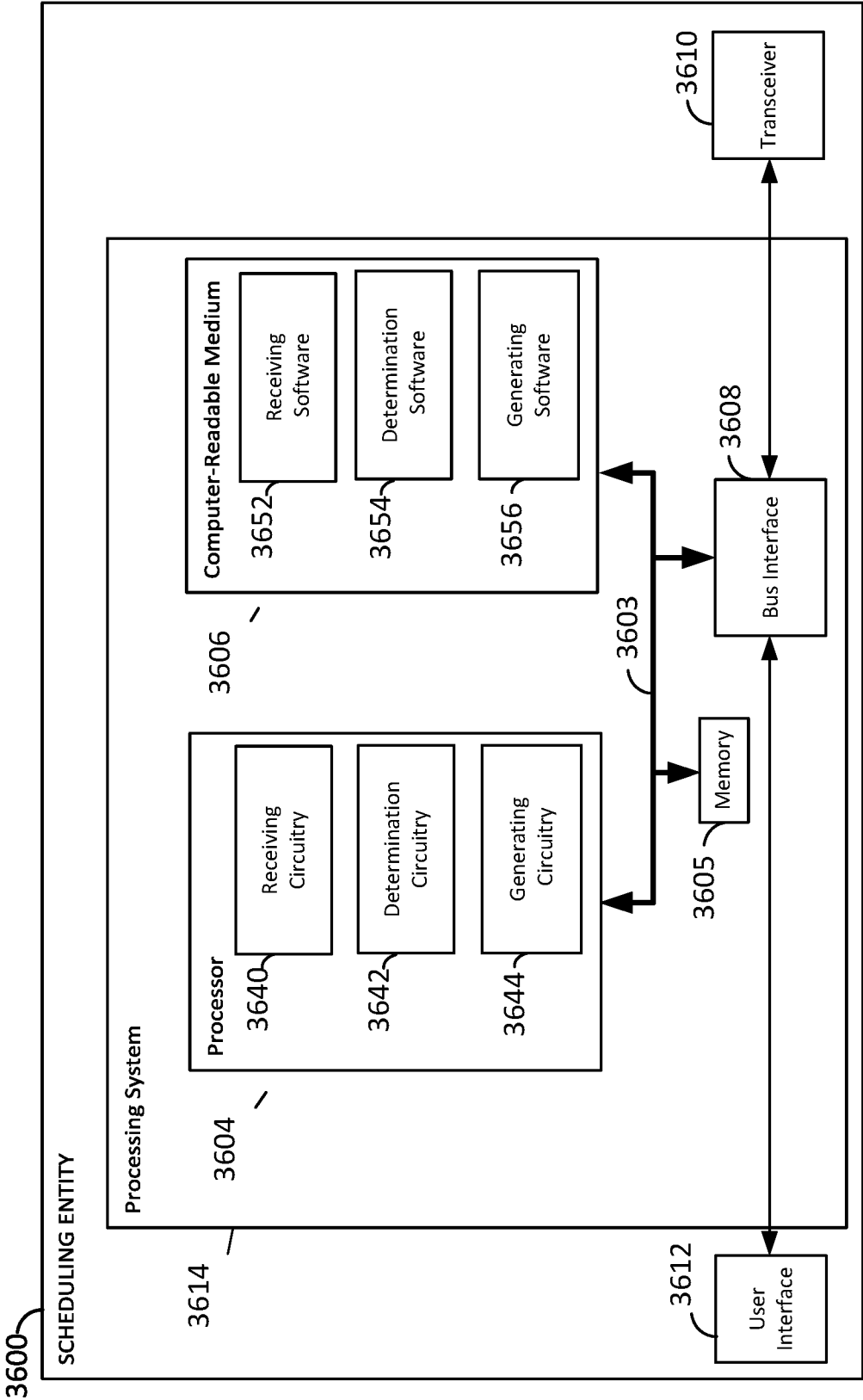
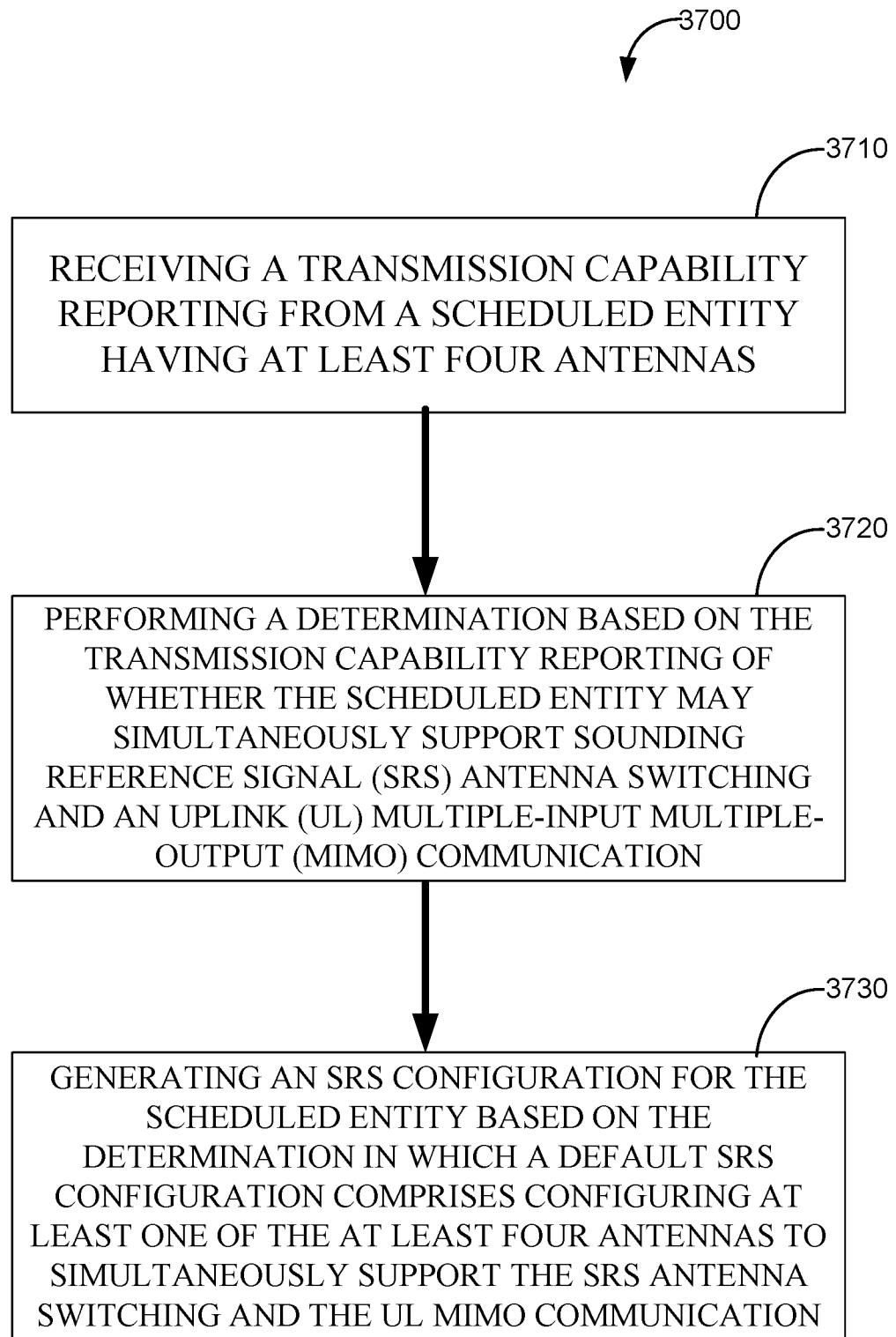


FIG. 36

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FIG. 37

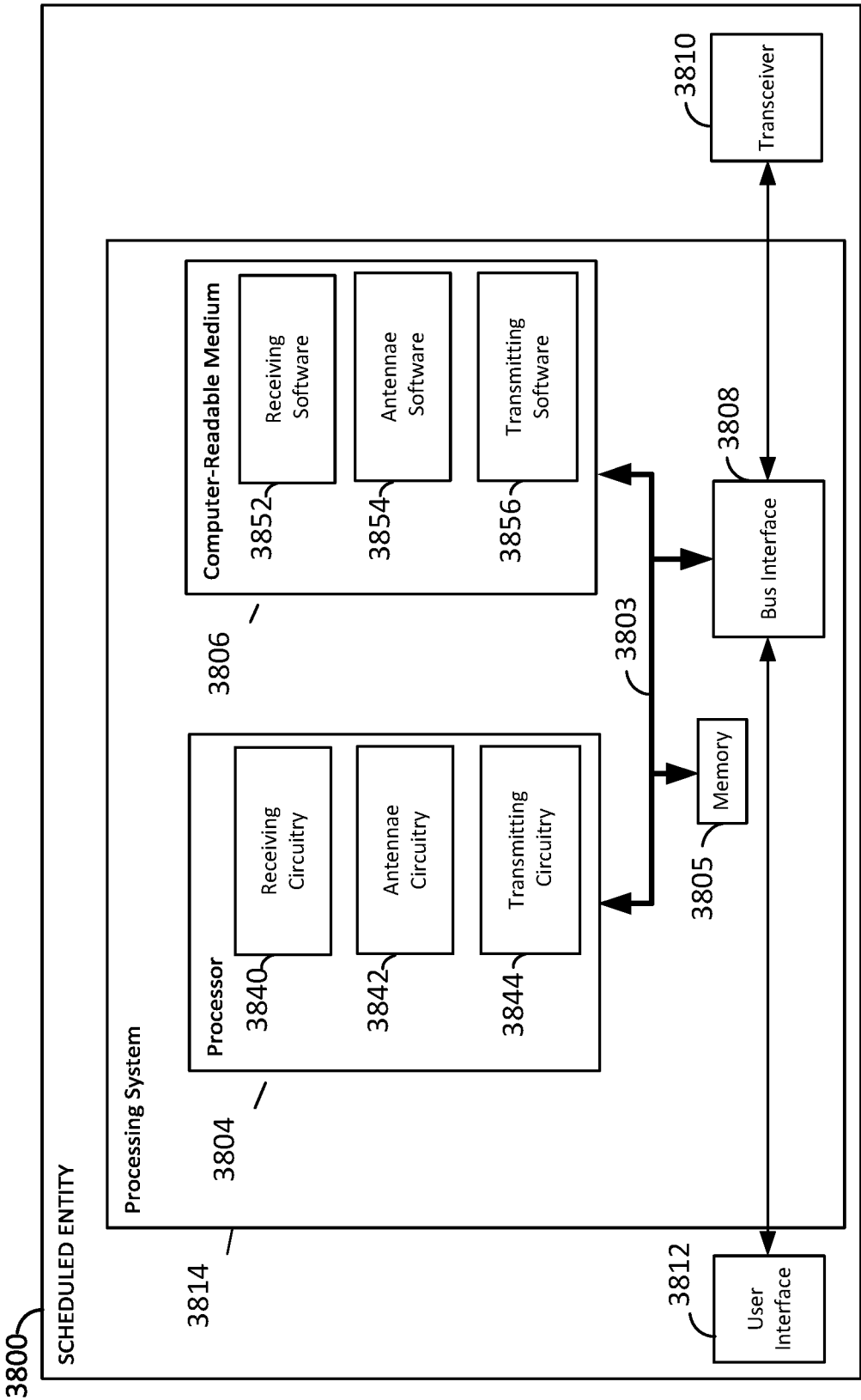


FIG. 38

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FIG. 39