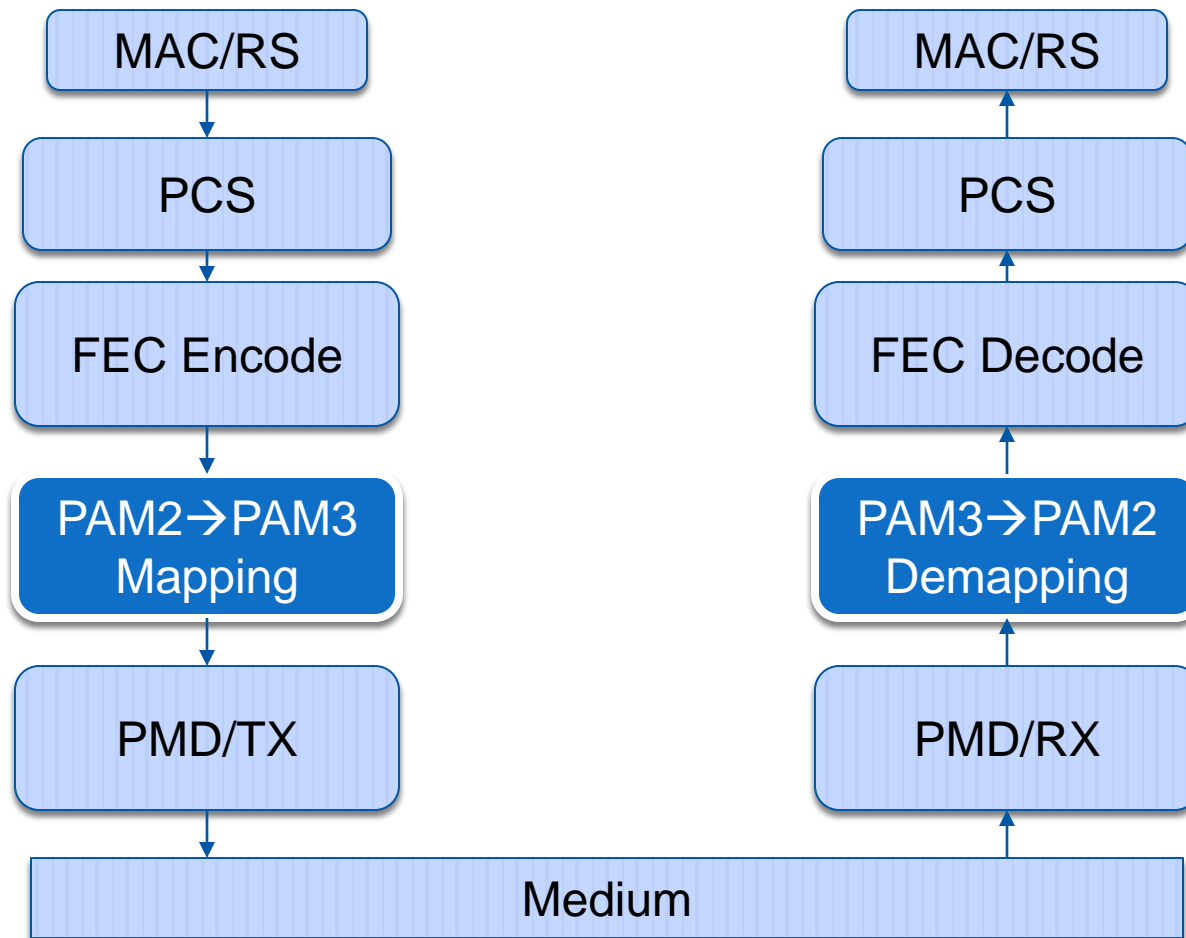


# PAM3 Mapping for 802.3bp

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# PAM3 Mapping in the PHY



# Criteria for Mapping

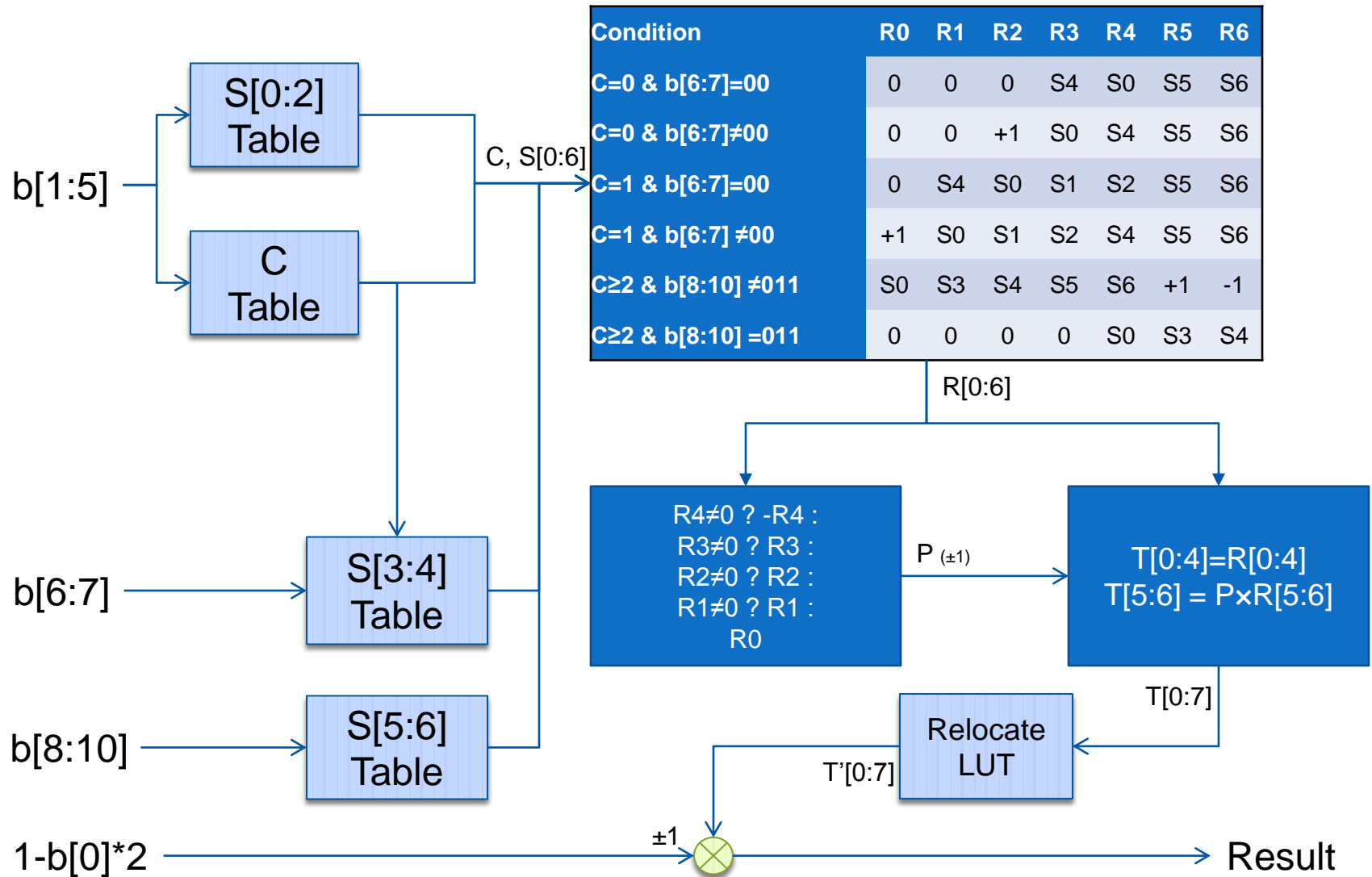
- We propose a PAM2→PAM3 mapping with:
  - Efficient use of bandwidth
  - Easy implementation
  - PSD property for Tx mask
  - Sufficient timing information

# Efficiency

- For easy implementation, we want to convert N bits into M PAM3 symbol
  - No memory
- 11bit→7PAM3 is an efficient choice
- Alternatively: 19bit→12PAM3
  - Implementation complexity is higher

# of PAM3 Symbol	Capacity (bits)	# of bits	Efficiency
2	3.1699	3	94.6%
3	4.7549	4	84.1%
5	7.9248	7	88.3%
<b>7</b>	<b>11.0947</b>	<b>11</b>	<b>99.2%</b>
9	14.2647	14	98.1%
11	17.4346	17	97.5%
<b>12</b>	<b>19.0196</b>	<b>19</b>	<b>99.9%</b>

# Mapper Diagram



# Tables

C and S[0:2] Table					
b[3:5]		S[0:2], C			
	b[1:2]=	00	01	10	11
000		000, 1	0-0, 1	+00, 1	+-0, 1
001		00+, 1	0-+, 1	+0+, 1	+-+, 1
010		00-, 1	0--, 1	+0-, 1	+--, 1
011		-00, 1	-0-, 1	-+0, 1	+XX, 2
100		0+0, 1	0XX, 0	++0, 1	--0, 1
101		0++, 1	+XX, 0	+++ , 1	--+, 1
110		0+-, 1	-XX, 0	++-, 1	---, 1
111		-0+, 1	0XX, 2	-++ , 1	+XX, 3

S[3:4] Table		
b[6:7]	S[3:4]	
	C≠3	C=3
00	0+	--
01	+-	-0
10	++	0-
11	+0	00

S[5:6] Table	
b[8:10]	S[5:6]
000	--
001	-0
010	0-
011	-+
100	++
101	+0
110	0+
111	00

Relocate Table		
T		T'
+++++++		+------
+++++++0		+-----0
++++++0+		+----0-
+++++0++		+---00
+++0+++		+---0+
++0++++		+---+0
+0+++++		+---++
0++++++		+--0+0
0+-0-+-		0+---++
0+-+0+-		0++--+-
+ -0-0-+		+0---++
+ -00+-+		+--+0+-
+0+-0-+		+---++
+0+0-+-		+0++--
00+0-+-		00++--
0+-0-+-		0+0-++
++-0-+-		++++-+
+ -00-+-		0000++
+ -0-+-0		0+-----
+ -0-+0+		0+---0
+ -+0+-0		0+---+
+ -+0+0+		0+-+0+
+0+-+-0		000+0+
+0+-+0+		000+++

'+' = +1, '-' = -1, '0' = 0, 'X'=do not care

# PSD and Extra PAM3 Patterns

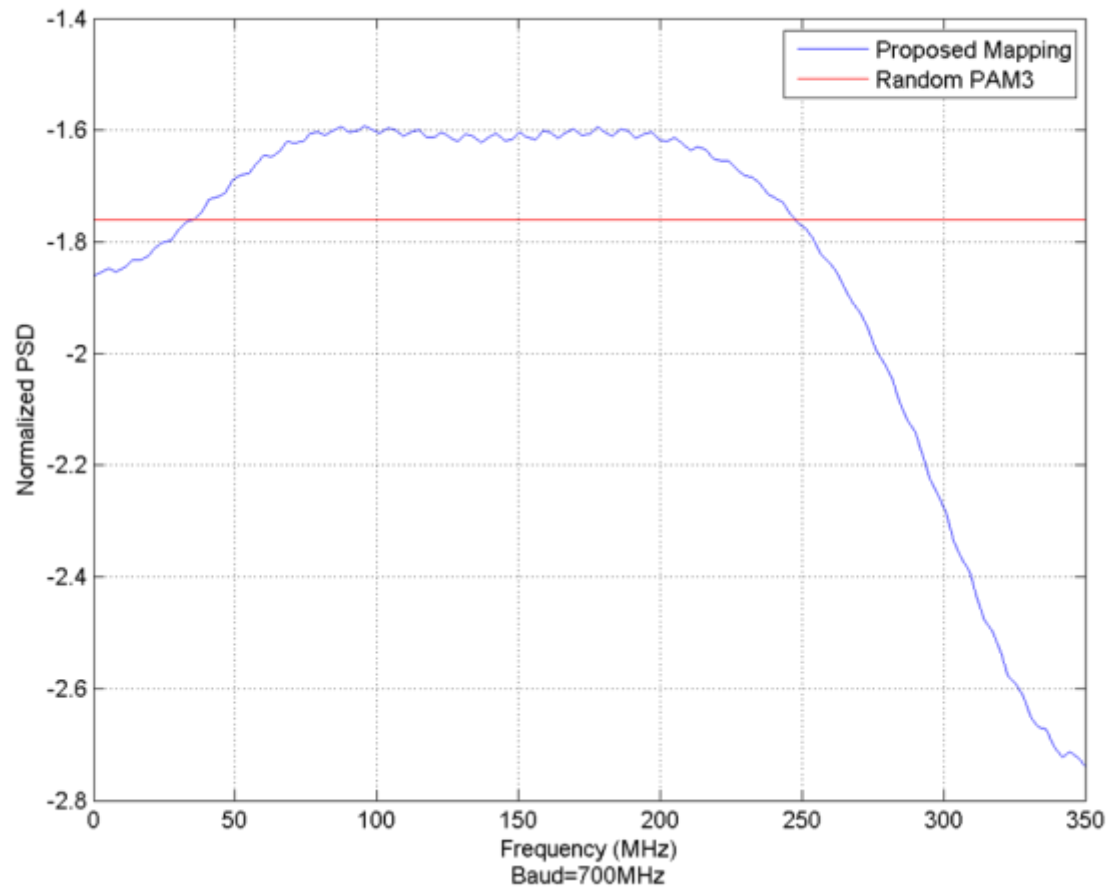
- We have  $3^7 - 2^{11} = 139$  extra constellation points
- Some “high frequency” patterns are selectively removed to shape the PSD
  - Result is a slightly low-pass PSD (~1.1dB attenuation)
  - Can help to fit Tx PSD mask
- Some high DC patterns are also removed

# Timing Information

- “Flat” patterns are removed to guarantee transition
  - ++++++, 0000000, -----, etc.
- Maximum run length is 12



# PSD



*Simulated with PRBS31 input*

# Error Correction Considerations

- It is difficult to find “Gray-like” code for PAM3 mapping
- Single PAM3 error will propagate to multiple bit errors
- Can be mitigated by employing  $GF(2^{11})$  symbols in RS code

Thank you!