

## PN Sequences and Scramblers

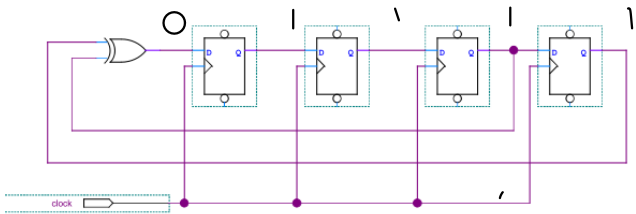
**Exercise 1:** How many bits are there in an m-sequence for  $m = 6$ ?  
How many are 1's? How many are 0's?

$$2^m - 1 = 2^6 - 1 = 63$$

$$2^{m-1} - 1 = 31 \text{ zeros}$$

$$2^{m-1} = 32 \text{ ones}$$

**Exercise 2:** If the initial value of each flip-flop is 1, what are the values of the next 4 bits output by the right-most flip-flop?



The bit shifted in is the XOR of the rightmost two bits:

1	1	1	1
0	1	1	1
0	0	1	1
0	0	0	1
1	0	0	0
0	1	0	0
0	0	1	0
1	0	0	1

1	1	0	0
0	1	1	0
1	0	1	1
0	1	0	1
1	0	1	0
1	1	0	1
1	1	1	0
1	1	1	1

period → 15

**Exercise 3:** How many flip-flops would be required to generate a ML PRBS of period 8191? How many ones would the sequence have? What is the longest sequence of 0's?

$$8191 = 2^m - 1$$

$$8192 = 2^m$$

$$m = \log_2(8192) = 13$$

$$2^{13-1} = 2^{12} = 4096$$

longest sequence of zeros is  $m-1 = 12$  bits

**Exercise 4:** Why not? the descrambling procedure is known.

**Exercise 5:** How many errors will appear in the output of a V.34 descrambler if there is one input error?

3: 1 for error at input

2 for each time the error reaches a tap in the shift register.

**Exercise 6:** In the diagram above, what two signals would the receiver compare to detect errors?

