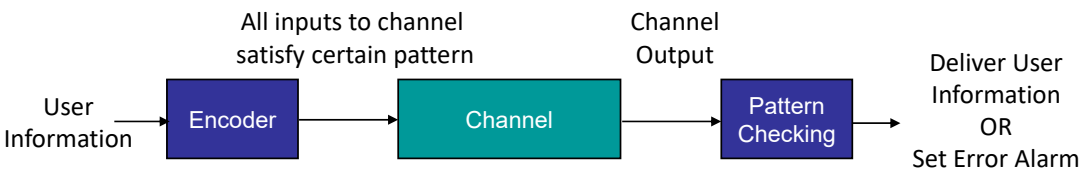
Topic 3: Error Detection and Recovery

General Error Detection System

- Transmitter (encoder) adds redundancy to user information to become codewords and transmit codewords over communication channel
- All transmitted codewords satisfy certain pattern that is agreed upon between transmitter and receiver
- If a received codeword doesn't satisfy the pattern, it is in error
  - Error detected!



Example: Single Parity Check Code

- Append an overall parity check bit to k information bits

  Information Bits: $(b_{k-1}, \ldots, b_1, b_0)$

  Parity Check Bit: $b_k = (b_{k-1} + \ldots + b_1 + b_0) \bmod 2$

  Codeword: $(b_k, b_{k-1}, \ldots, b_1, b_0)$

- Pattern: all codewords have even # of 1's
- Receiver checks whether # of 1's is even
  - All errors that change an odd number of bits are detectable
  - All even-numbered errors are undetectable
- Parity check bit is used in ASCII characters

Error Vector

- Suppose we transmit a codeword that has n bits

- Define the error vector $\underline{e} = [e_{n-1}, \ldots, e_1, e_0]$ where
  - $e_i = 1$ if error occurs to the i^{th} bit position
  - $e_i = 0$ otherwise

- Fraction of Undetectable Errors (FUE)
  - FUE = total # undetectable errors / total # valid errors

Error Burst

- Errors can be classified according to:
  - Number of bit error positions: M-bit error
  - Separation of bit error positions: error burst of length L
    - Error starts at bit position i and ends at bit position (i + L - 1)