Convolutional Codes

- Generates redundant bits continuously
- Error checking and correcting carried out continuously
- \((n, k, K)\) code
  - Input processes \(k\) bits at a time
  - Output produces \(n\) bits for every \(k\) input bits
  - \(K\) = constraint factor
  - \(k\) and \(n\) generally very small
- \(n\)-bit output of \((n, k, K)\) code depends on:
  - Current block of \(k\) input bits
  - Previous \(K-1\) blocks of \(k\) input bits

Decoding

- Trellis diagram – expanded encoder diagram
- Viterbi code – error correction algorithm
  - Compares received sequence with all possible transmitted sequences
  - Algorithm chooses path through trellis whose coded sequence differs from received sequence in the fewest number of places
  - Once a valid path is selected as the correct path, the decoder can recover the input data bits from the output code bits

Figure 8.9 Convolutional Encoder with \((n, k, K) = (2, 1, 3)\)
Automatic Repeat Request

- Mechanism used in data link control and transport protocols
- Relies on use of an error detection code (such as CRC)
- Flow Control
- Error Control

Turbo Coding

- Used for 3G wireless systems
- Exhibit performance close to Shannon’s limit (wrt bit error probability)
- Refer to Figures 8.13, 8.14 and 8.15

Flow Control

- Assures that transmitting entity does not overwhelm a receiving entity with data
- Protocols with flow control mechanism allow multiple PDUs in transit at the same time
- PDUs arrive in same order they’re sent
- Sliding-window flow control
  - Transmitter maintains list (window) of sequence numbers allowed to send
  - Receiver maintains list allowed to receive
- Reasons for breaking up a block of data before transmitting:
  - Limited buffer size of receiver
  - Retransmission of PDU due to error requires smaller amounts of data to be retransmitted
  - On shared medium, larger PDUs occupy medium for extended period, causing delays at other sending stations
**Flow Control**

Mechanisms to detect and correct transmission errors

Types of errors:
- Lost PDU: a PDU fails to arrive
- Damaged PDU: PDU arrives with errors

**Error Control Requirements**

- Error detection
  - Receiver detects errors and discards PDUs
- Positive acknowledgement
  - Destination returns acknowledgment of received, error-free PDUs
- Retransmission after timeout
  - Source retransmits unacknowledged PDU
- Negative acknowledgement and retransmission
  - Destination returns negative acknowledgment to PDUs in error

**Go-back-N ARQ**

- Acknowledgments
  - RR = receive ready (no errors occur)
  - REJ = reject (error detected)
- Contingencies
  - Damaged PDU
  - Damaged RR
  - Damaged REJ

![Figure 8.17 Sliding-Window Depiction](image)