Transmission Errors

- Errors due to following factors
  - Thermal noise.
  - Impulse noise.
  - Signal distortion.
- Impulse is worst offender.
- Must provide methods of error detection and correction.

Cyclic Redundancy Code CRC

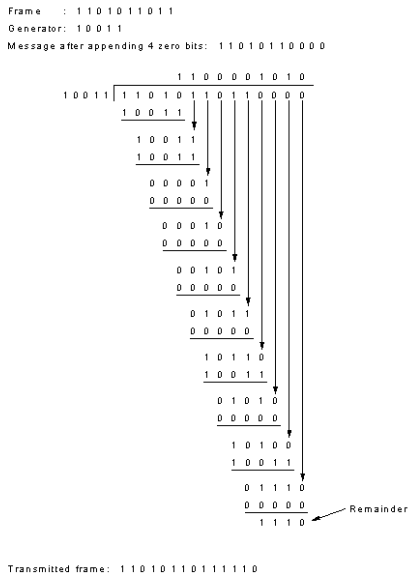
- Error Detecting Code (not correcting!)
- Nomenclature
  - A string of N bits may be represented as an N-1 degree polynomial with co-efficient of 0 or 1.
  - F = 110001
  - $F(x) = x^5 + x^4 + x^0$
- Modulo 2 arithmetic.
  - Addition and Subtraction identical… XOR

CRC Algorithm

- Sender & receiver agree on G(x) generator polynomial.
- Append R 0 bits to M(x), the message, where R is the degree of G(x), this yields
  - $x^R * M(x)$
- Divide G(x) into $x^R * M(x)$.
- Add remainder to $x^R * M(x)$, result T(x)

CRC Example

- M(x) = 1101 0110 11
- $x^R * M(x)$ = 1101 0110 1100 00
- G(x) = 10011 *or* $x^4 + x^1 + x^0$
- Remainder should be 1110
- T(x) transmitted message should be
  - 1101 0110 11 1110
- This will be evenly divisible by G(x) !



Standard CRCs

- CRC-12
  - $x^{12} + x^{11} + x^3 + x^2 + x + 1$
- CRC-16
  - $x^{16} + x^{15} + x^2 + 1$
- CRC-CCITT
  - $x^{16} + x^{12} + x^5 + 1$
- CRC-32
  - $x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x + 1$