Digital Communication

For

Advance Training Course in Met.

Instrumentation and Information System

By-

Manish Rai

Scientist C

भारत मौसम विज्ञान विभाग

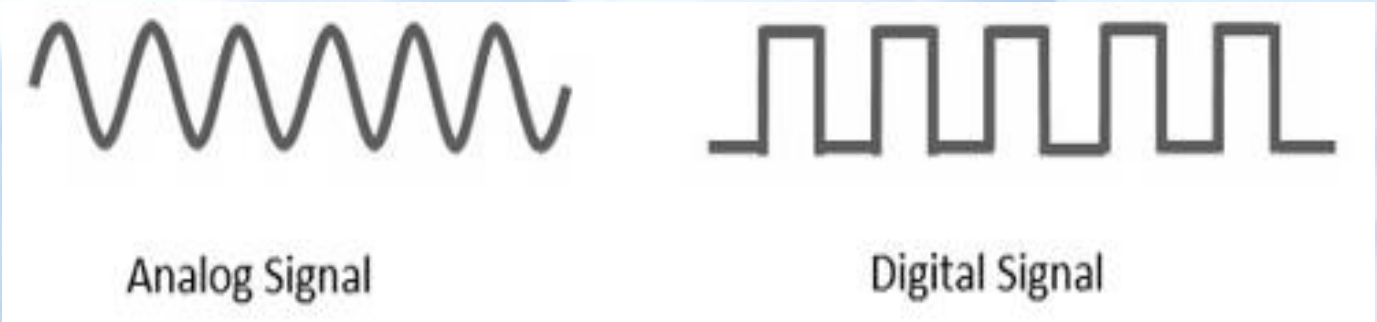
INDIA METEOROLOGICAL DEPARTMENT

The Necessity of Digitization

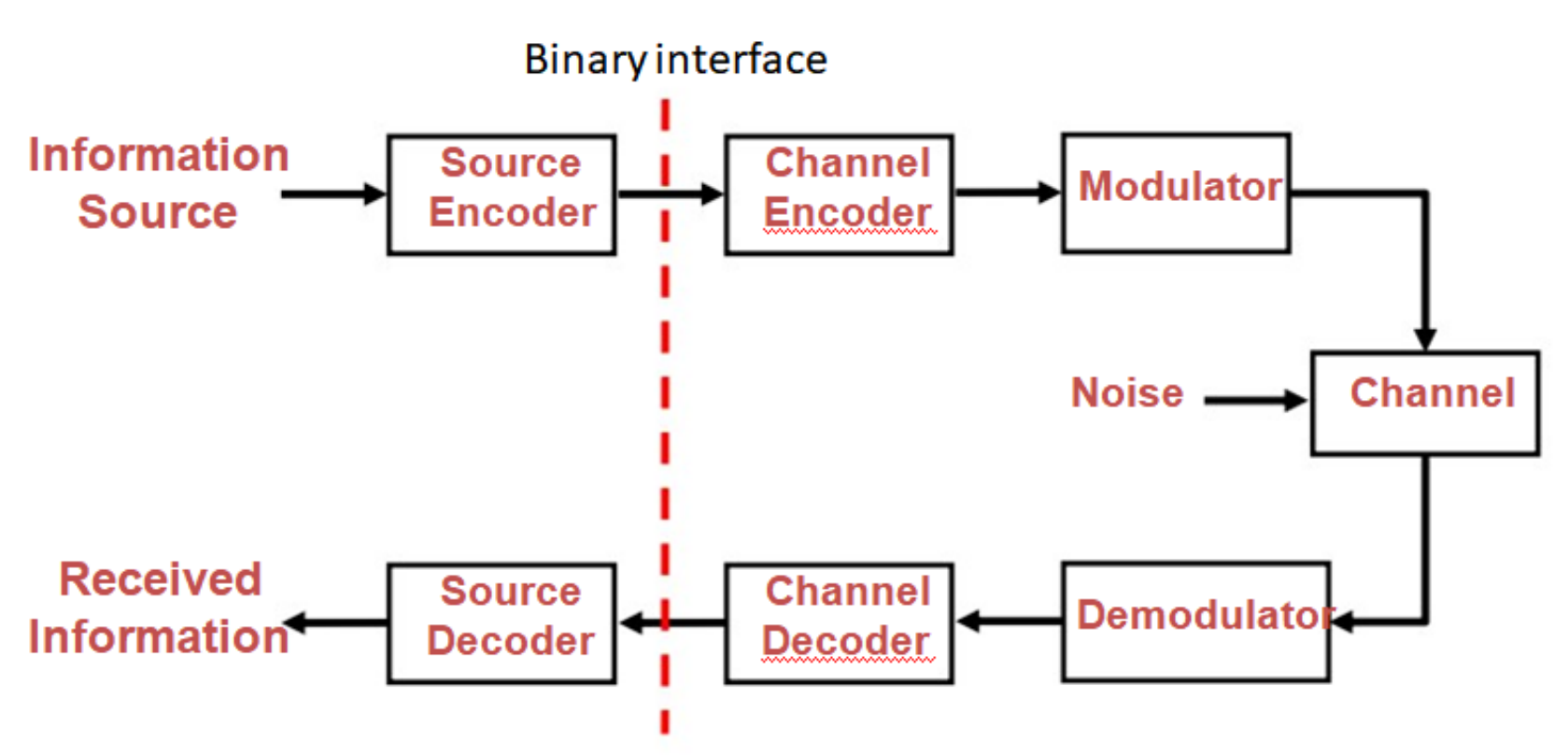
The conventional methods of communication used analog signals for long distance communications, which suffer from many losses such as distortion, interference, and other losses including security breach.

In order to overcome these problems, the signals are digitized using different techniques. The digitized signals allow the communication to be more clear and accurate without losses.

The following figure indicates the difference between analog and digital signals. The digital signals consist of 1s and 0s which indicate High and Low values respectively.



Simplified block diagram of a Digital communication system



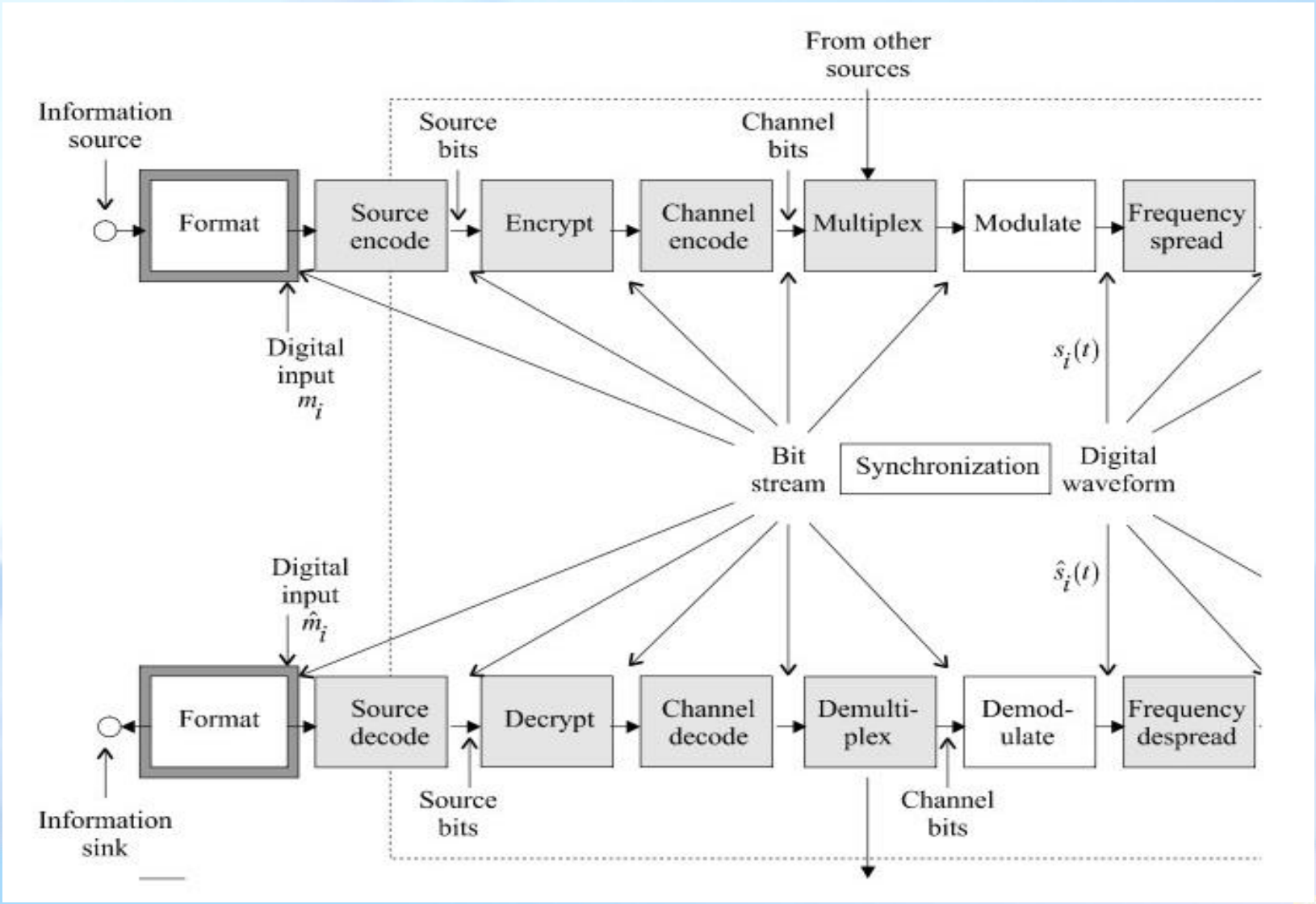
Source Encoder

- **Sampling**
  - makes signal discrete in time
  - signals can be sampled without introducing distortion
- **Quantization**
  - makes signal discrete in amplitude
  - Good quantizers are able to use few bits and introduce small distortion
- **Source Coding**
  - compression of digital data to eliminate redundant information (squeeze out redundant information)
  - does not introduce distortion

Channel Encoder

- **Encryption**
  - ensures data privacy
- **Channel coding**
  - Provides protection against transmission errors by selectively inserting redundant data
  - plays an extremely important role in system design
- **Modulation**
  - Converts digital data to a continuous waveform suitable for transmission (usually a sinusoidal wave)
  - Information is transmitted by varying one or more parameters of the transmitted signal
    - Varying Phase such as in Phase Shift Keying (PSK)
    - Varying Frequency such as in Frequency Shift Keying (FSK)
    - Varying Amplitude such as in Amplitude Shift Keying (ASK)

More Detailed view



Communication Channels - Examples

- Wireline channels
  - Telephone network
  - Twisted-pair wire lines and coaxial cable
- Fiber-optic channels
  - Higher bandwidth, > GHz
- Underwater acoustic channels
  - With increasing interest, but very challenging to design
- Storage channels
  - Magnetic tape, magnetic disks, optical disks, compact disks
- Wireless channels

Communication Channels

- **Channel carries the transmitted signals**
  - could be a telephone wire, free space and often presents distorted signal to demodulator
- **Effects include**
  - Attenuation - Transmitted power typically decreases as inverse of square distance
  - Noise (e.g., additive white Gaussian noise or AWGN.)
  - Filtering
    - Channel can have a bandwidth that is small compared to the signal bandwidth (e.g., in a telephone channel).
    - Transmitted pulses will be changed in shape and smeared out in time causing Inter-symbol interference or ISI.
  - Fading
    - Signal amplitude can change in a random fashion
  - Time Variation
    - Time-varying channels cause signal fading.
    - Different components of the signal can be faded at different levels and this often causes random filtering of the signals (hence ISI).

What are the Features of a Good Communication System?

- Small signal power (measured in Watts or dBm)
- Large data rate (measured in bits/sec)
- Small bandwidth (measured in Hertz)
- Low distortion (measured in SNR or bit error rate)
- Low cost - with digital communications, large complexity does not always result in large cost

In practice, tradeoffs have to be made in achieving these goals.

Thanks
for your support