## Modulation techniques

Pulse amplitude modulation, Digital pulse modulation

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#### Analog Pulse Modulation techniques

- lacksquare Sample ightarrow Pulse
- Pulse properties: amplitude, width, phase/position
- Modulation technique for each property: PAM, PWM, PPM

### Pulse Amplitude Modulation

- lacksquare Sequence of pulses with finite width au
- Signal level → pulse height
- Analog signal sampled at pulse edge:  $m_{\delta} = m(nT_s)\delta(t nT_s)$
- Holding circuit:  $h(t) = rect(\frac{t \frac{1}{2}\tau}{\tau})$

#### **Delta Modulation**

- Delta modulation technique in which the message signal is encoded into a sequence of binary symbols.
- It is an analog to digital and digital to analog conversion technique.
- It is the simplest form of DPCM cause the transmitted data are reduced to a 1-bit

#### Explaining the functions and Figures

- The input that pulse modulator need is:  $d(t) = m(t) m_s(t)$
- m(t) is the message signal and and  $m_s(t)$  is the reference waveform.
- d(t) is hard-limited and it will be multiplied by the pulse generator. So result will be:  $x_c(t) = \Delta(nT_s) * \delta(t nT_s)$
- Also reference signal will generate by integrating  $x_c(t)$ . Result will be:  $m_s(t) = \Delta(nT_s) * \int^t \delta(\alpha - nT_s) d\alpha$
- Demodulation of DM is accomplished by integrating  $X_c(t)$  to form stairstep approximation  $m_s(t)$



# **Figure**

#### Pulse-Code Modulation

- The generation of PCM is a three-step process. First,  $m_t$  gets sampled, secondly it gets quantinized and encoder.
- In PCM,quantized level is transmitted data instead of sample value.
- A binary "one" is represented as a pulse, and a binary "zero" represented as pulse.
- For the binary requirements, of a PCM system, suppose that q quantization levels following formula will be used:  $q=2^n$  where n is the word length, integer. For this case,  $n=log_2*q$ , binary pulses must be transmitted for each sample of the message signal.

### Time- Division Multiplexing

 Time-Division multiplexing is best understood by considering the figure below

