Modulation techniques

Pulse amplitude modulation, Digital pulse modulation

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Analog Pulse Modulation techniques

- Sample $\rightarrow$ Pulse
- Pulse properties: amplitude, width, phase/position
- Modulation technique for each property: PAM, PWM, PPM

Pulse Amplitude Modulation

- Sequence of pulses with finite width τ
- Signal level $\rightarrow$ 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

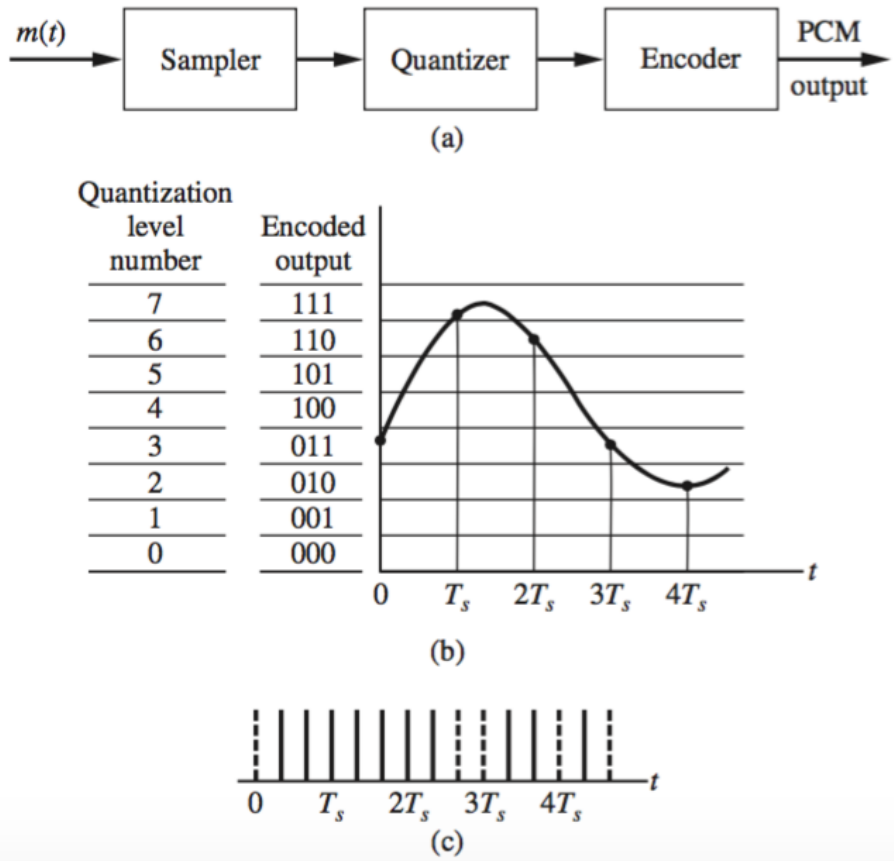

Figure: Investigating TDM

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

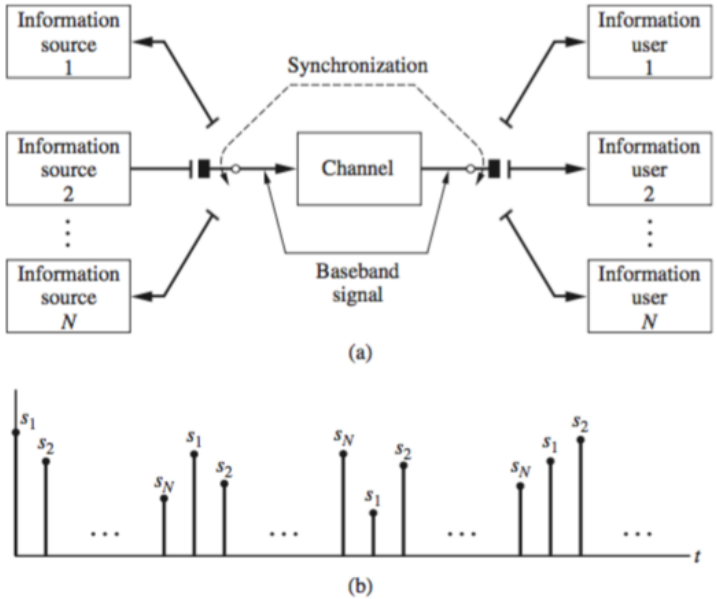

Figure: Investigating TDM.

Explanation of the graph

- At the channel output, the baseband signal is demultiplexed by using a second commutator. Than if all signals are synched in terms of bandwidths, samples are transmitted sequentially.
- If sampled signals have unequal bandwidths, more samples must be transmitted per unit time from the wideband channels.
- For the minimum bandwidth, following formula will be used:$\sum_{i=1}^{N} 2 * W_i * T = n_s$
- If it's a lowpass signal of bandwidth B, required sampled rate will be 2B. Formula will be:$\sum_{i=1}^{N} 2 * W_i * T = n_s = 2 * B * T$