DIFFERENTIAL PULSE CODE MODULATION (DPCM)

EEEN 464 – DIGITAL COMMUNICATION

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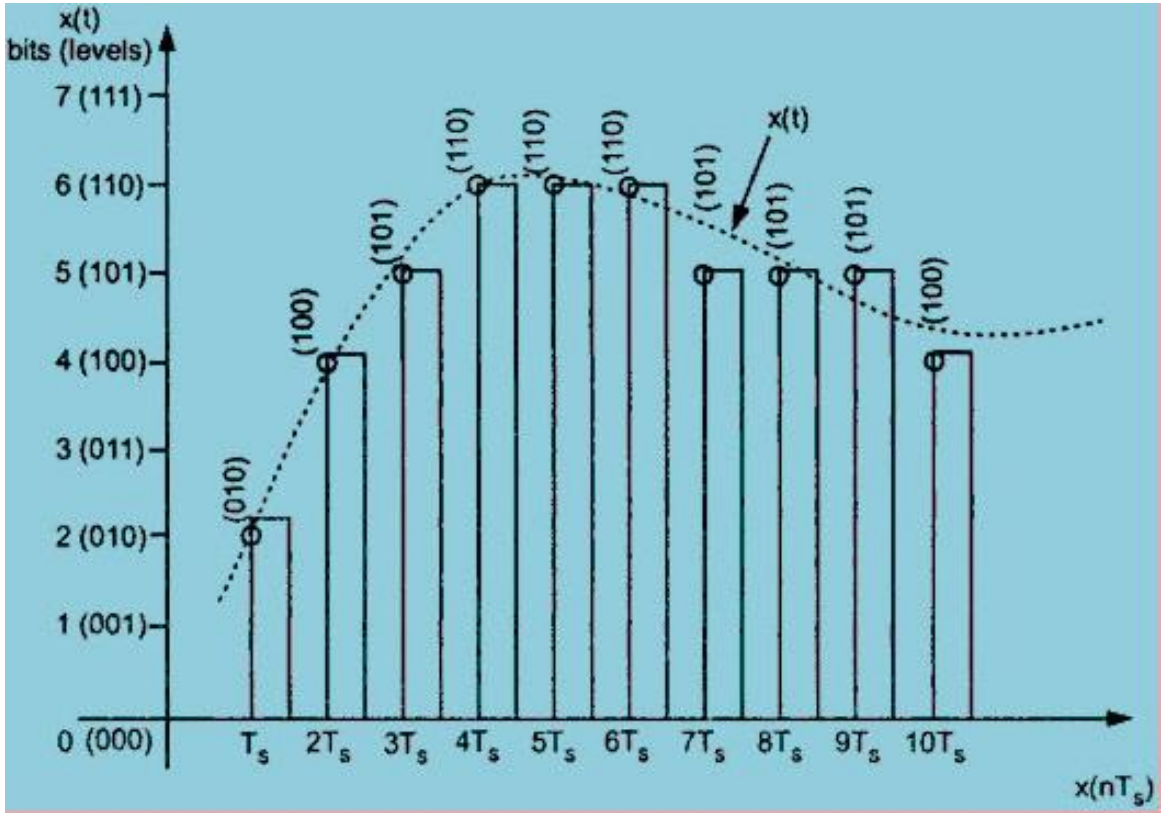
WHAT IS DIFFERENTIAL PULSE CODE MODULATION?

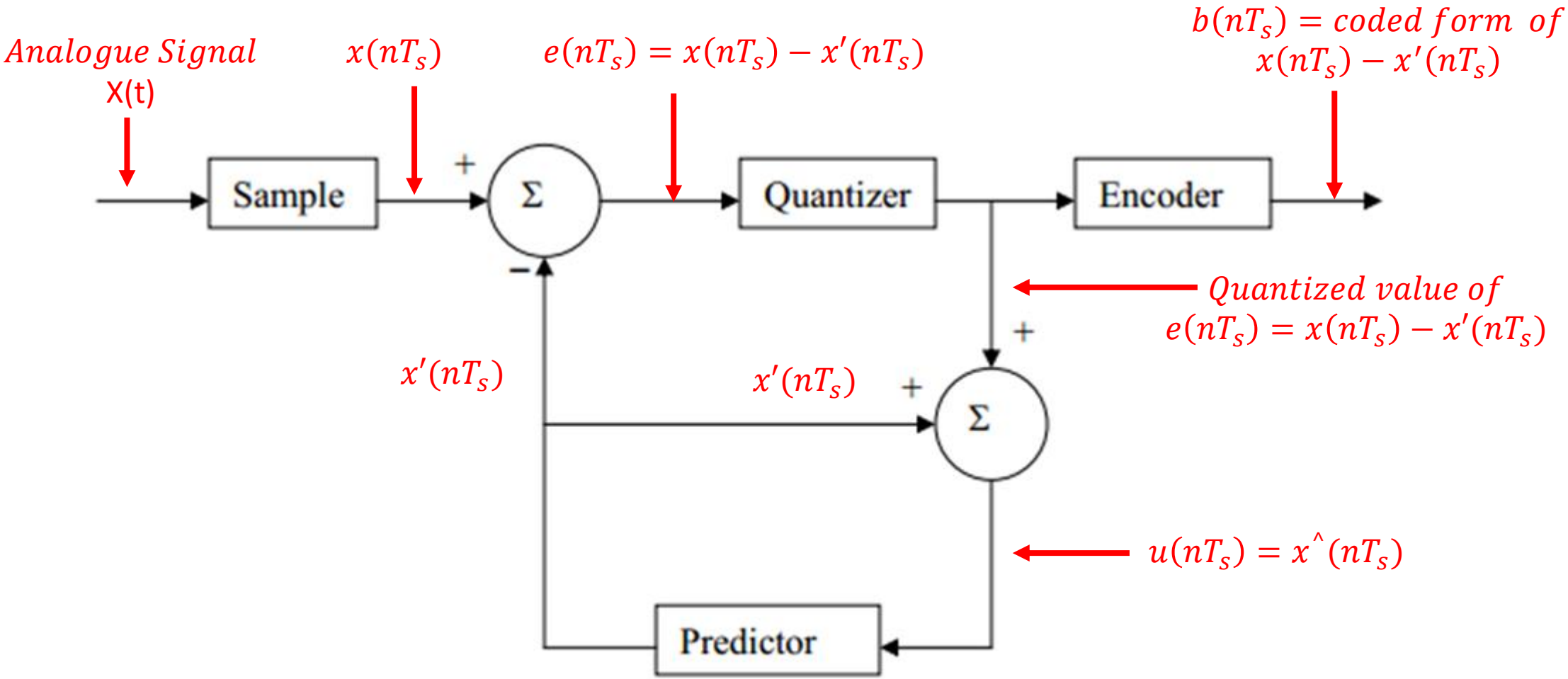
1. **Differential Pulse Code Modulation (DPCM)** is a signal encoding technique that utilizes the concept of adaptive delta modulation and PCM but with an added layer of prediction, where instead of quantizing the raw signal samples directly, **it quantizes the difference between the current sample and a predicted value based on previous samples.**
2. **DPCM** generates a more efficient bitrate, particularly for signals with high correlation between neighboring samples, e.g. Speech and video.



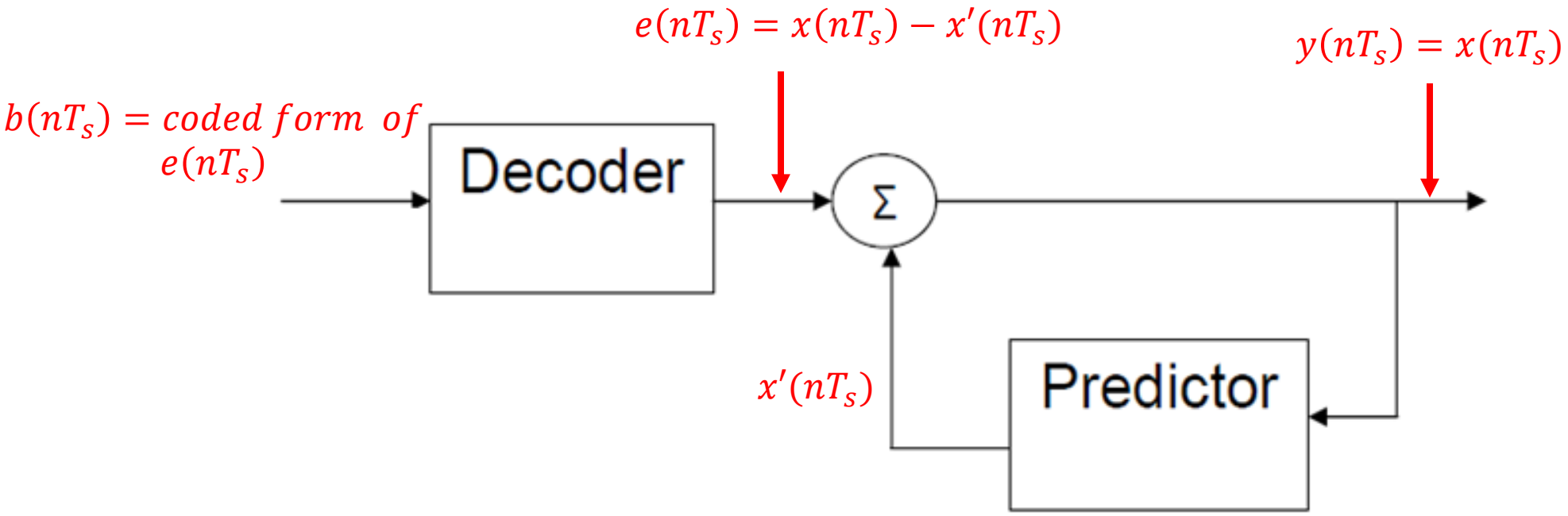
WHY DIFFERENTIAL PULSE CODE MODULATION?

1. Some signals such as speech have high correlation between adjacent samples.
2. When such highly correlated samples are encoded using basic PCM, the resulting code contains a lot of redundant information.
3. In such cases, basic PCM scheme is not the preferred coding method.
4. By removing this redundancy before encoding an efficient coded signal can be obtained.
5. One method of removing redundancy is by using the Differential PCM (DPCM) method.
6. **DPCM** is based on the principle that by knowing the past behaviour of a signal up to a certain point in time, it is possible to predict future values.

DPCM TRANSMITTER



DPCM RECEIVER



Predictor uses $\hat{x}(nT_s)$ and previous values to predict $x'(nT_s)$

COMPARING OF PCM, DELTA MODULATION AND ADAPTIVE PCM

1. **PCM** transmits the binary form of full sample value.
2. **DPCM** transmitting only the difference between consecutive samples.
3. **Delta Modulation uses a single bit** to indicate whether the signal is increasing or decreasing.
4. **DPCM and Delta Modulation** generally requiring less bandwidth than PCM.
5. **DPCM and Delta** have got poor signal quality due to slope and granular noise.

COMPARISON OF PCM, DELTA MODULATION AND ADAPTIVE PCM

N0	PARAMETER	PULSE CODE MODULATION (PCM)	DELTA MODULATION	ADAPTIVE PCM MODULATION
1	**Levels and Step Size**	Number of levels depend on number of bits Level size is fixed	Step size is fixed	Step size varies according to the rate at which the signal is varying
2	**Number of Bits**	Can take 4, 8 or 16 bits per sample	One bit per sample	One bit per sample
3	**Quantization errors and distortion**	Quantization noise is present	Has slope overload and granular noise	Quantization noise is present
4	**Bandwidth**	Highest bandwidth	Low bandwidth required	Least bandwidth required
5	**Feedback in transmitter or receiver**	No feedback	Feedback in transmitter	Feedback in transmitter
6	**Complexity in implementation**	High	Simple	Simple

APPLICATIONS OF DPCM

1. **Speech:** is used Speech and audio signal compression.
2. **Image and video processing:** In images, there is a correlation between the neighboring pixels. Similarly, in video signals, the correlation is between the same pixels in consecutive frames and inside frames

DPCM is suitable for real-time audio, image and video applications.