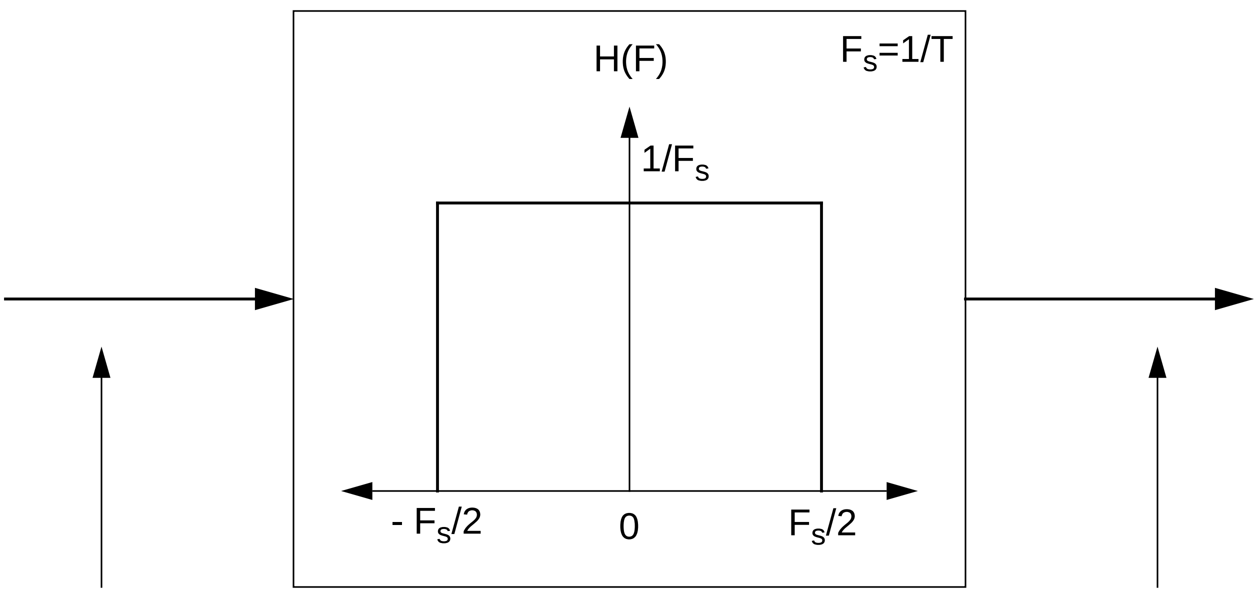
Digital to Analog (D/A) Conversion

Recall the sampling theorem:

$$x_a(t) = \sum_{n=-\infty}^{\infty} x_a(nT) \frac{\sin((\pi/T)(t-nT))}{(\pi/T)(t-nT)}$$

This can be viewed as a linear filtering process:



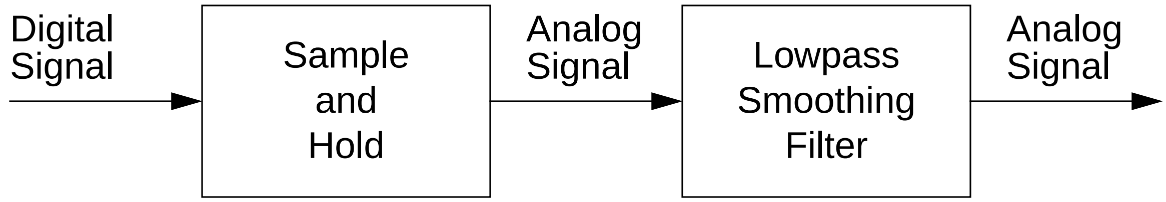
$$\sum_{n=-\infty}^{\infty} x(nT)\delta(t-nT)$$

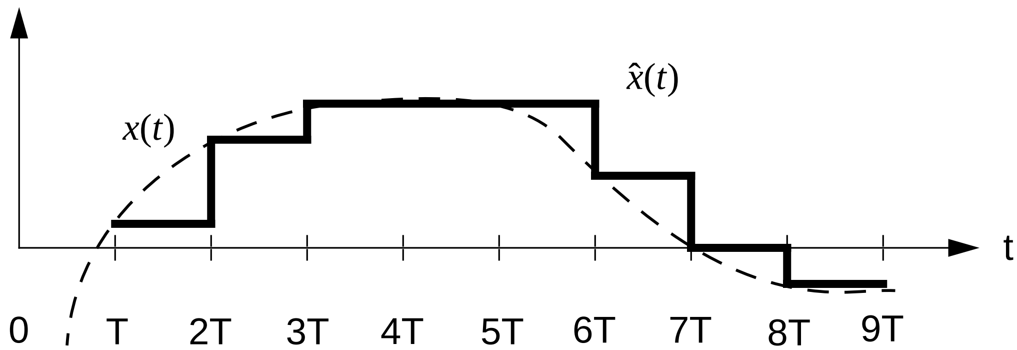
$$x_a(t) = \sum_{n=-\infty}^{\infty} x_a(nT) \frac{\sin((\pi/T)(t-nT))}{(\pi/T)(t-nT)}$$

What does $h(t)$ look like?

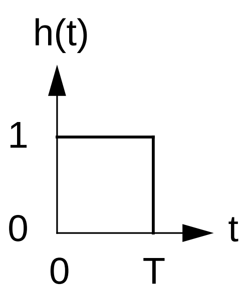
What is wrong with this approach?

Practical D/A: Sample and Hold

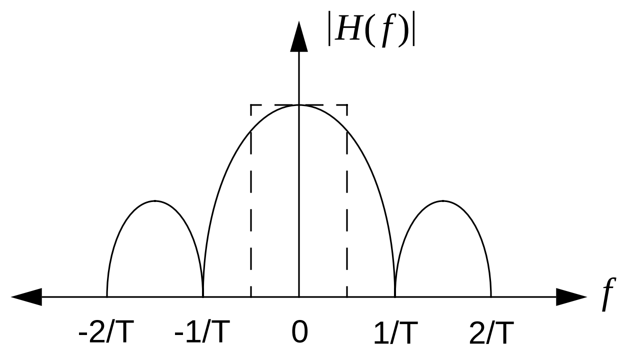




Note that h(t) for the sample and hold is given by:

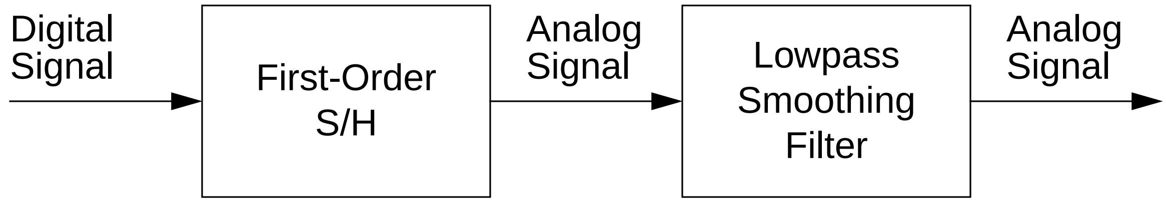


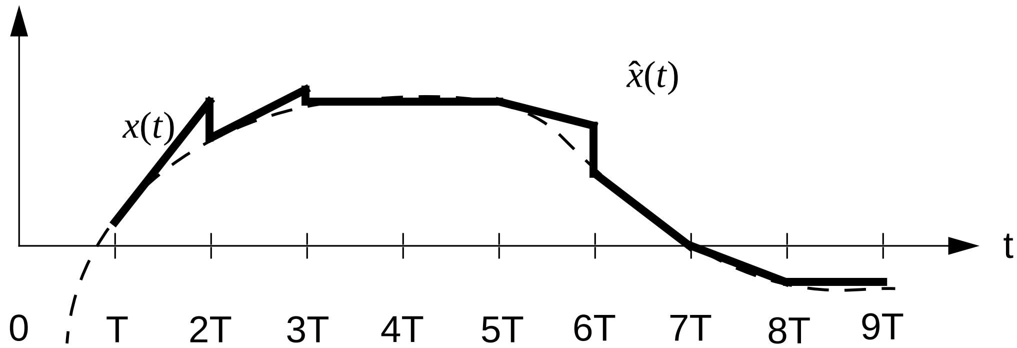
and H(F) is given by:



What is wrong with this approach?

Can We Do Better? First-Order Hold



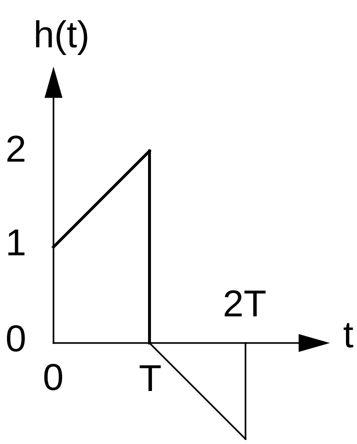


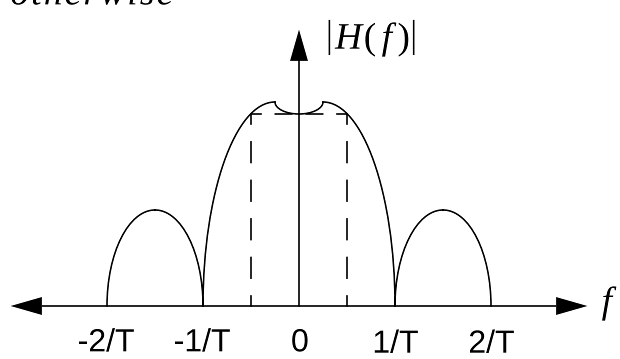
The difference equation is as follows:

$$\hat{x}(t) = x(nT) + \frac{x(nT) - x(nT - T)}{T} t - nT, \qquad nT \le t < (n+1)T$$

The impulse response is given by:

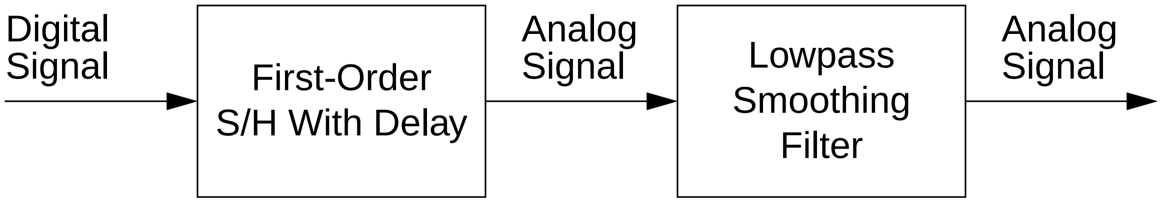
$$h(t) = \begin{cases} 1 + \frac{t}{T}, & 0 \le t \le T \\ 1 - \frac{t}{T}, & T \le t \le 2T \\ 0, & otherwise \end{cases}$$

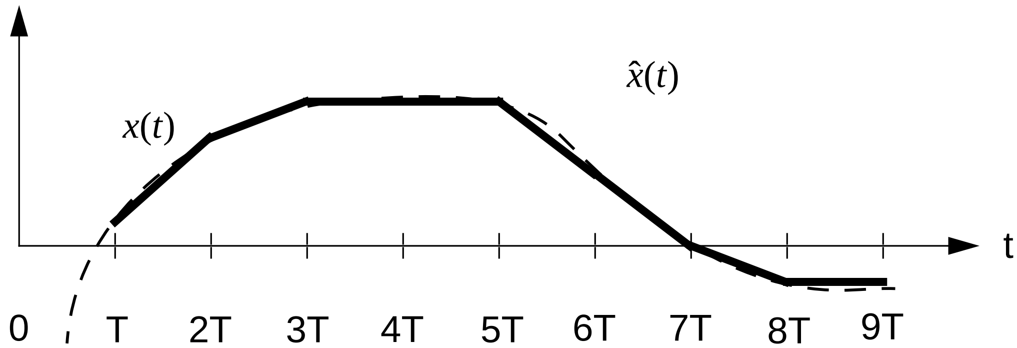




What is wrong with this approach?
(Note that the slope is fixed at the current sample point!)

Can We Do Better? Linear Interpolation With Delay



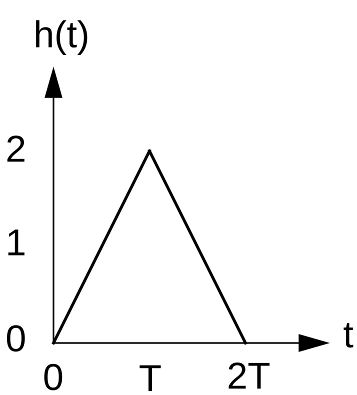


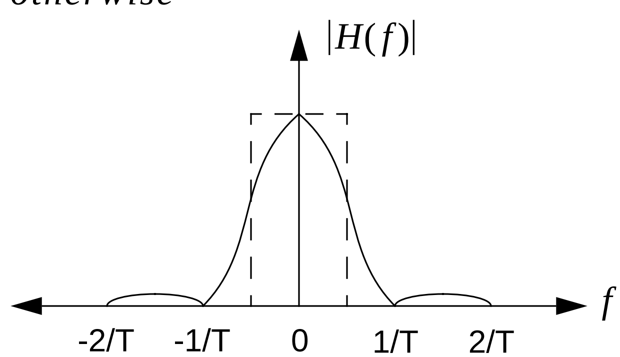
The difference equation is as follows:

$$\hat{x}(t) = x(nT - T) + \frac{x(nT) - x(nT - T)}{T} t - nT, \qquad nT \le t < (n+1)T$$

The impulse response is given by:

$$h(t) = \begin{cases} \dfrac{t}{T}, & 0 \le t \le T \\ 2 - \dfrac{t}{T}, & T \le t \le 2T \\ 0, & otherwise \end{cases}$$





What is the cost in this approach? Can we do even better???

Oversampled A/D's are state-of-the-art.