Filtering With the DFT

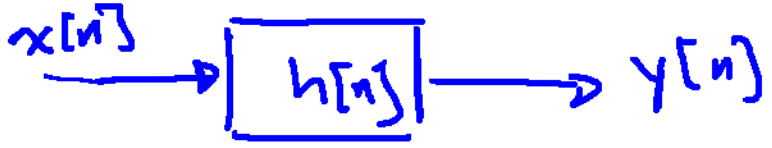
$$y[n] = x[n] * h[n] = \sum_{k=0}^{M_h-1} h[k]\,x[n-k]$$

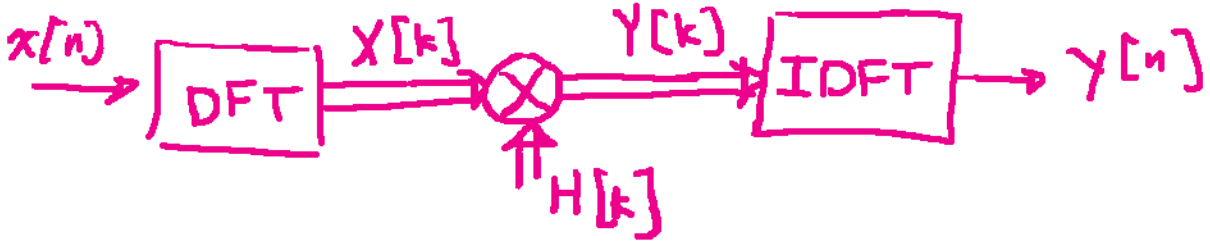
$$\xleftrightarrow{\text{DTFT}}$$

$$Y(e^{j\omega}) = X(e^{j\omega})\,H(e^{j\omega})$$

$$\downarrow \text{DFT}$$

$$Y[k] = X[k]\,H[k]$$

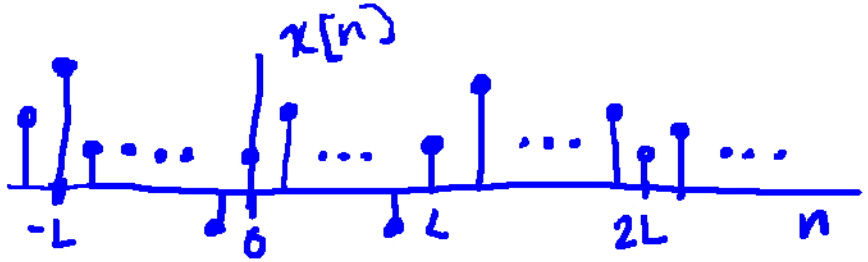




- Compute one output sample ($y[n]$) at a time

- Block of $x[n]$ $\longrightarrow$ Block of $y[n]$
- DFT length $N \geq M_h + M_x - 1$
- Can be "faster"

What if x[n] is not finite duration?



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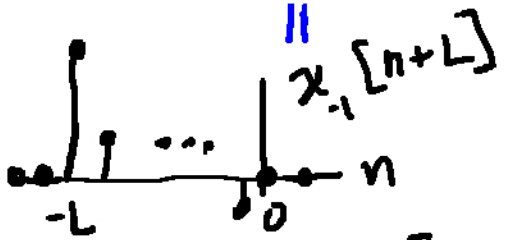

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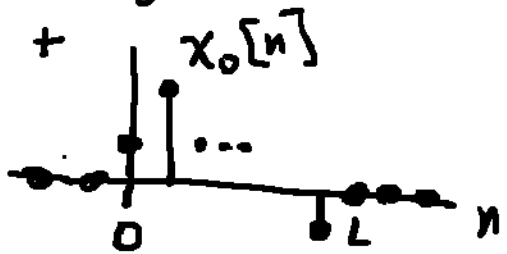

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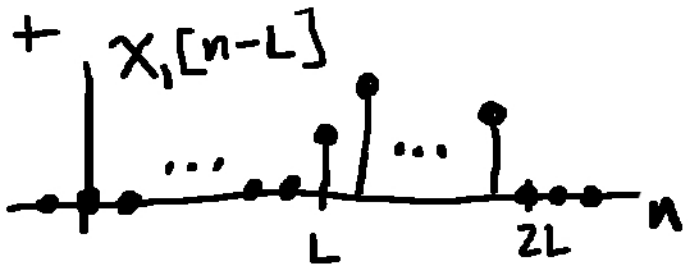
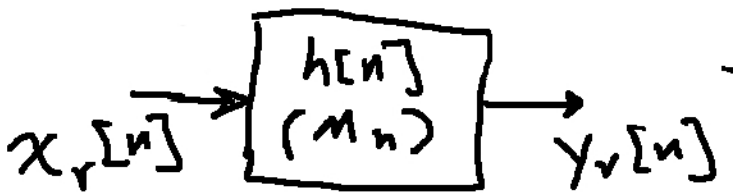


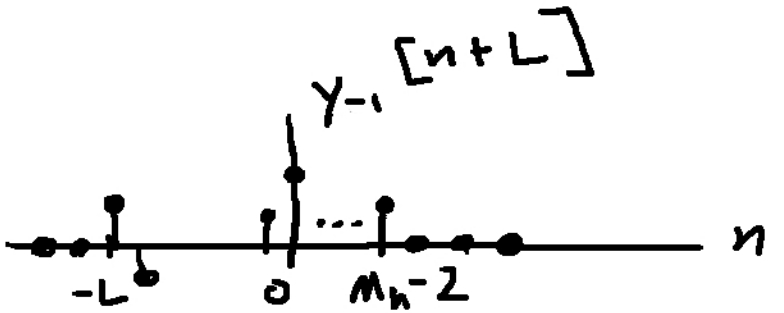
$$x[n] = \sum_{r=-\infty}^{\infty} x_r[n-rL]$$



$$y[n] = x[n] * h[n]$$

$$= \sum_r x_r[n-rL] * h[n]$$

$$= \sum_r y_r[n-rL]$$



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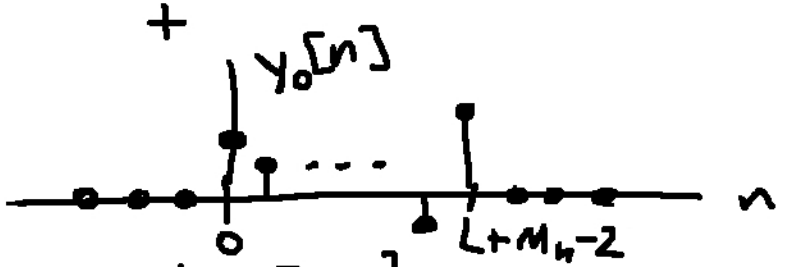

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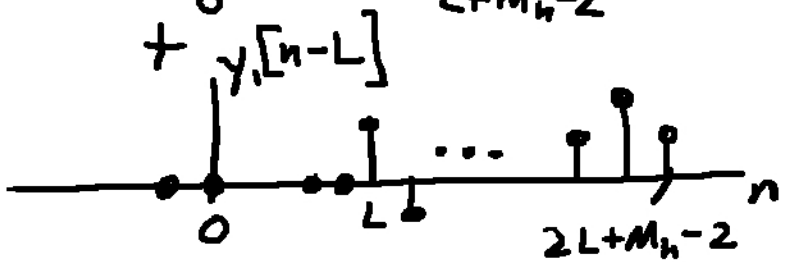

Called: "Overlap and add" method

1) Calculate $y_r[n]$ using $N \geq L + M_h - 1$ point DFTs

2) Add up shifted $y_r[n]$: $y[n] = \sum_r y_r[n - rL]$