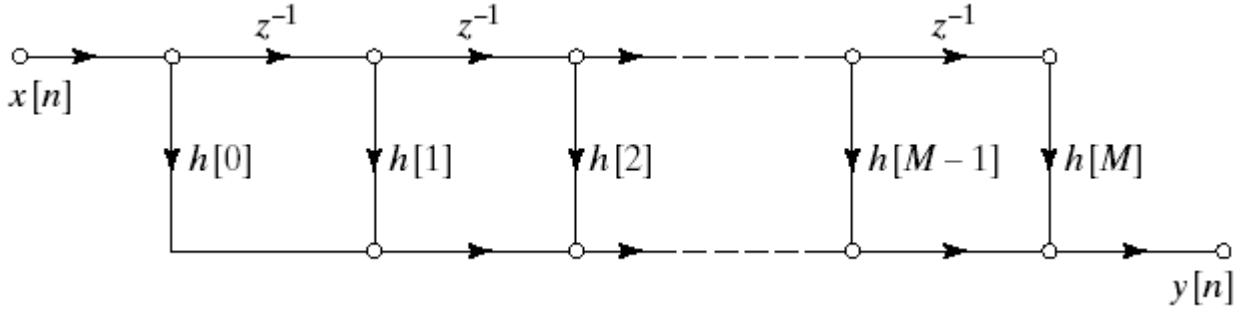
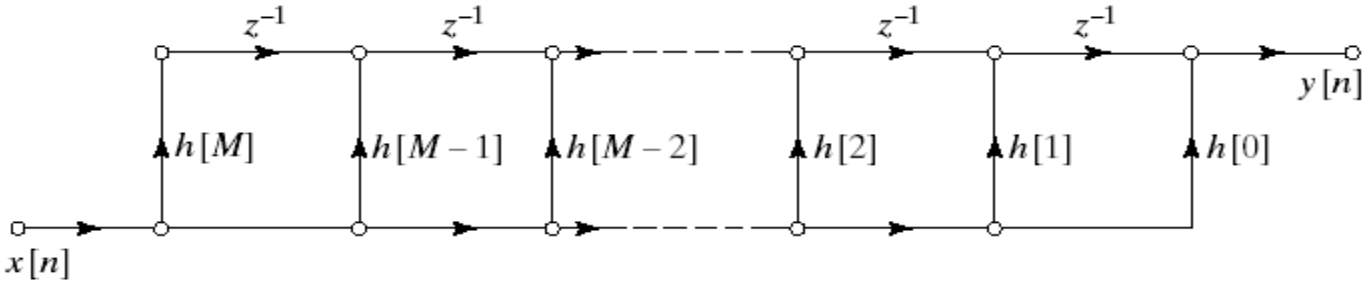
FIR systems

Basic Structures for FIR Systems: Direct Form

- Specia



- Transpose of direct form I gives direct form II
- Both forms are equal for FIR systems

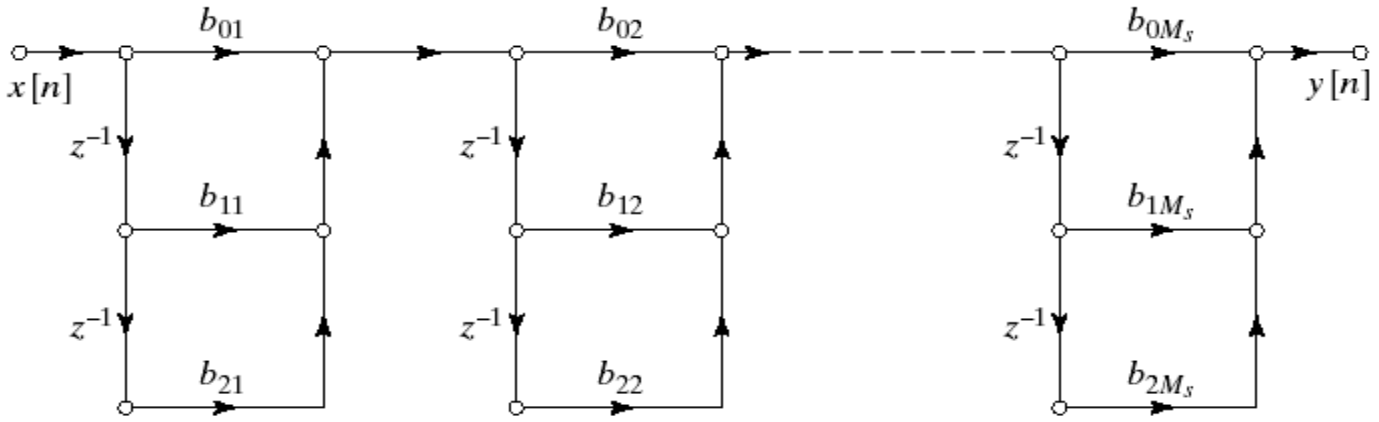


- Tapped delay line

Basic Structures for FIR Systems: Cascade Form

- Obtained by factoring the polynomial system function

$$H(z) = \sum_{n=0}^{M} h[n] z^{-n} = \prod_{k=1}^{M_S} \left(b_{0k} + b_{1k} z^{-1} + b_{2k} z^{-2} \right)$$



Structures for Linear-Phase FIR Systems

- Causal FIR system with generalized linear phase are symmetric:

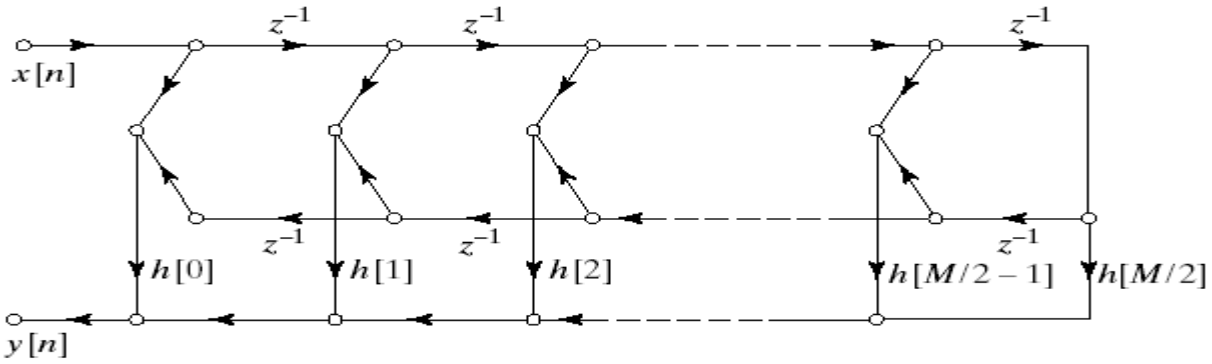
$$h[M-n] = h[n] \qquad n = 0,1,\ldots,M \quad \text{(type I or III)}$$
$$h[M-n] = -h[n] \qquad n = 0,1,\ldots,M \quad \text{(type II or IV)}$$

- Symmetry means we can half the number of multiplications
- Example: For even M and type I or type III systems:

$$y[n] = \sum_{k=0}^{M} h[k]x[n-k] = \sum_{k=0}^{M/2-1} h[k]x[n-k] + h[M/2]x[n-M/2] + \sum_{k=M/2+1}^{M} h[k]x[n-k]$$
$$= \sum_{k=0}^{M/2-1} h[k]x[n-k] + h[M/2]x[n-M/2] + \sum_{k=0}^{M/2-1} h[M-k]x[n-M+k]$$
$$= \sum_{k=0}^{M/2-1} h[k](x[n-k] + x[n-M+k]) + h[M/2]x[n-M/2]$$

Structures for Linear-Phase FIR Systems

- Structure for even M



- Structure for odd M