11.10 Filter Banks

What Are Filter Banks?

Often need to slice up a “wideband” signal into various “subbands”

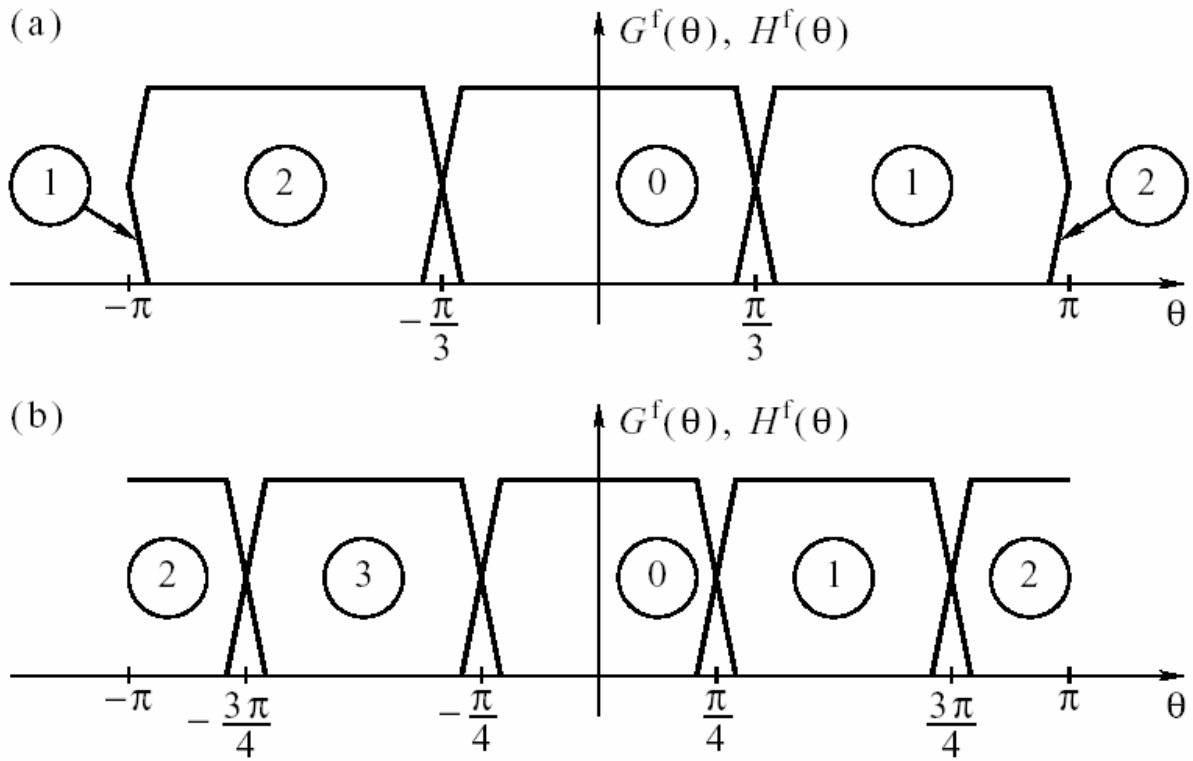


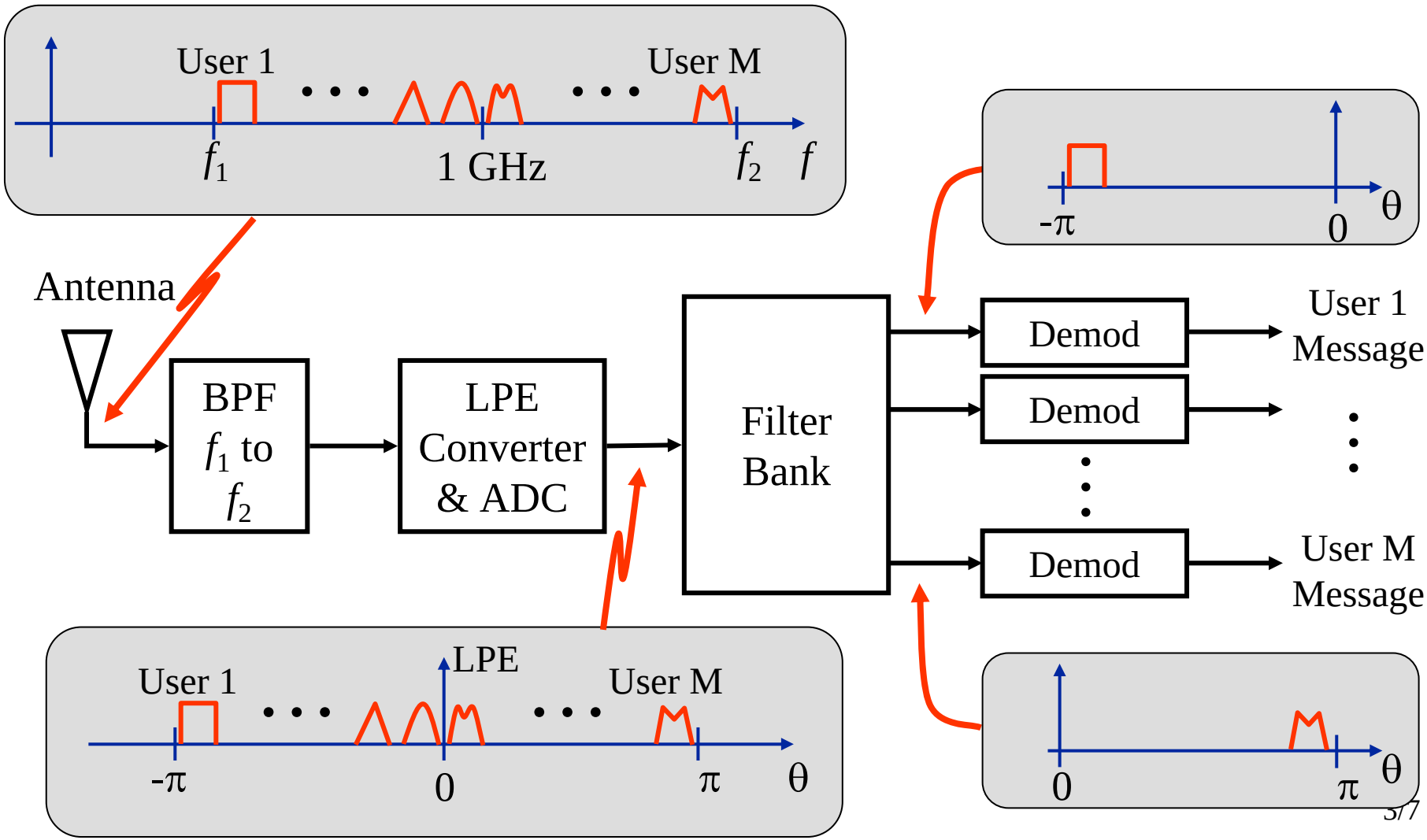
Figure 12.25 Division of the frequency range into bands in subband processing: (a) odd number (shown for $M = 3$); (b) even number (shown for $M = 4$).

Figure from Porat’s Book

Filter Banks Application: Cell Phone Basestation

FDMA = Frequency-Division Multiple Access

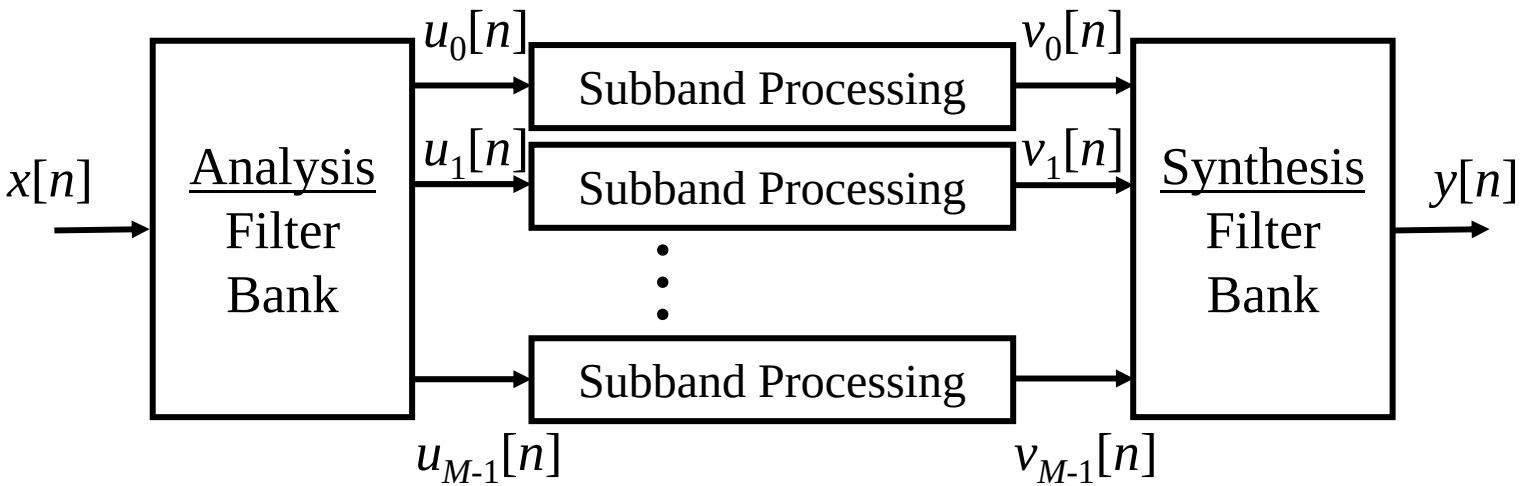
Each user (or set of users) is assigned a different band



Filter Banks & Subband Processing

Sometimes we want to:

- Split a signal into subbands using an "analysis" filter bank
- Process each subband
- Then… re-assemble subbands using a "synthesis" filter bank

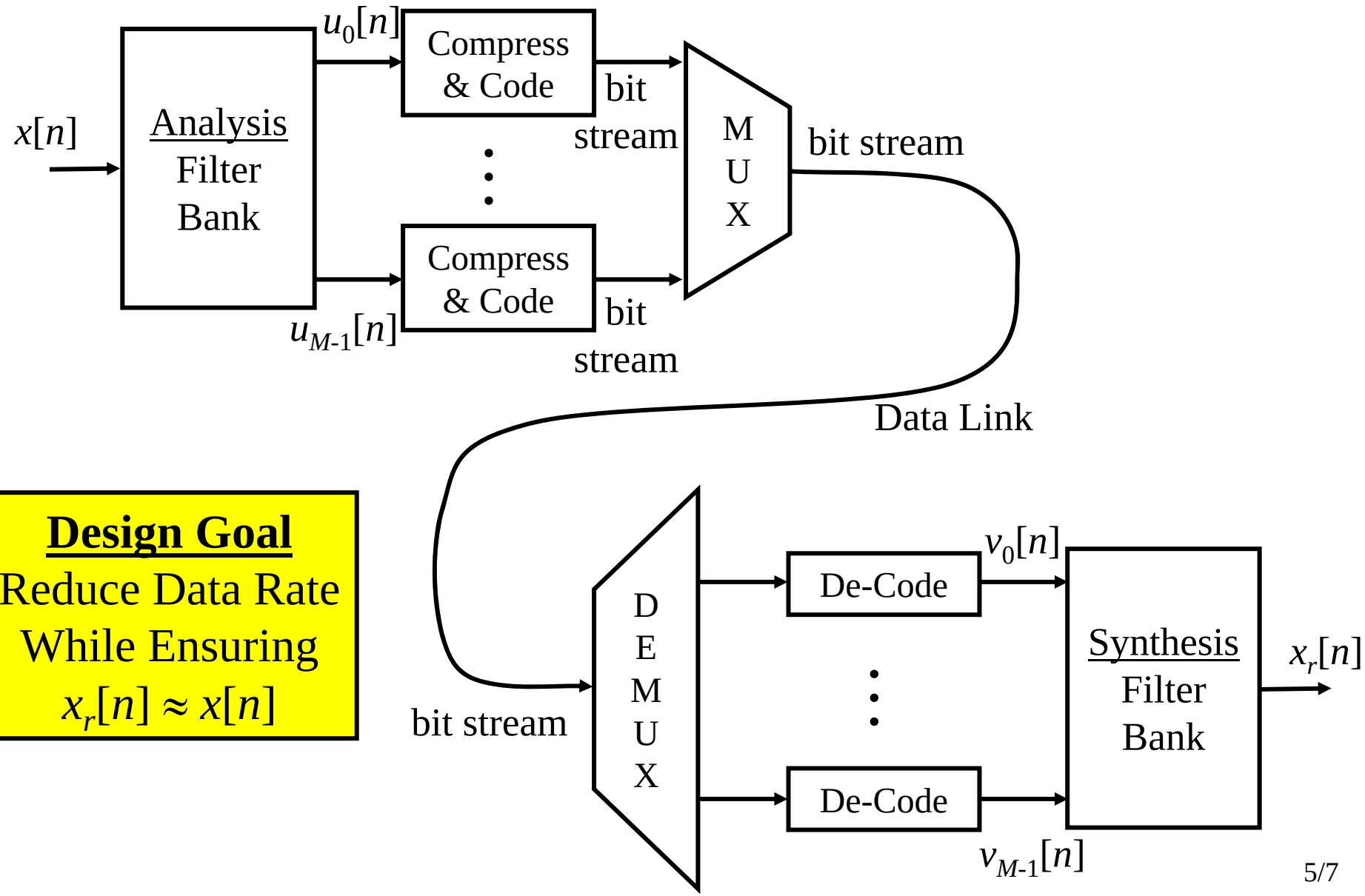


Usual Design Goal: Design so that if the subband processing does nothing (i.e., imagine that $v_i[n] = u_i[n]$) we get:

$$y[n] = c\, x[n - l]$$

"Perfect Reconstruction (PR) Property"

Example: Subband Data Compression



Design Goal

Reduce Data Rate While Ensuring $x_r[n] \approx x[n]$

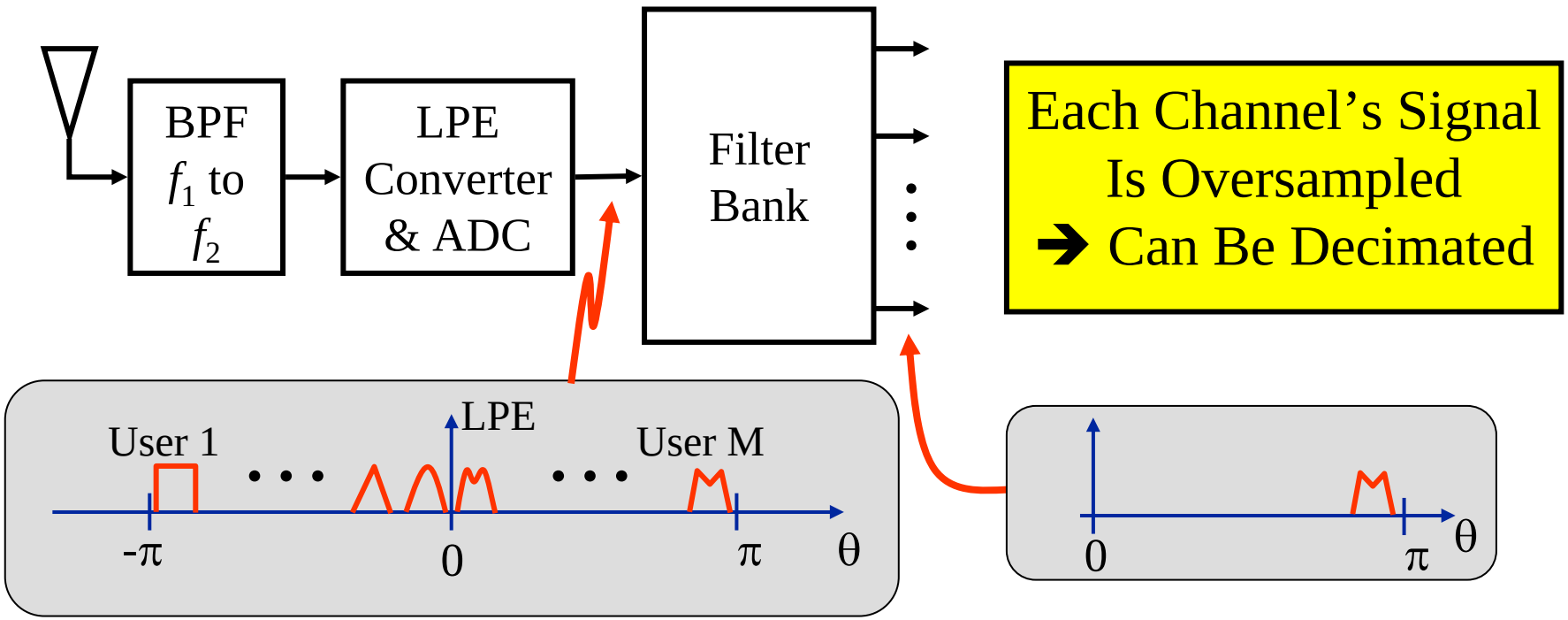
Decimated Filter Banks

Each output channel of a filter bank spans only a fraction of the input BW:

Whole digital BW = 2π Each of M subbands has BW = $2\pi/M$

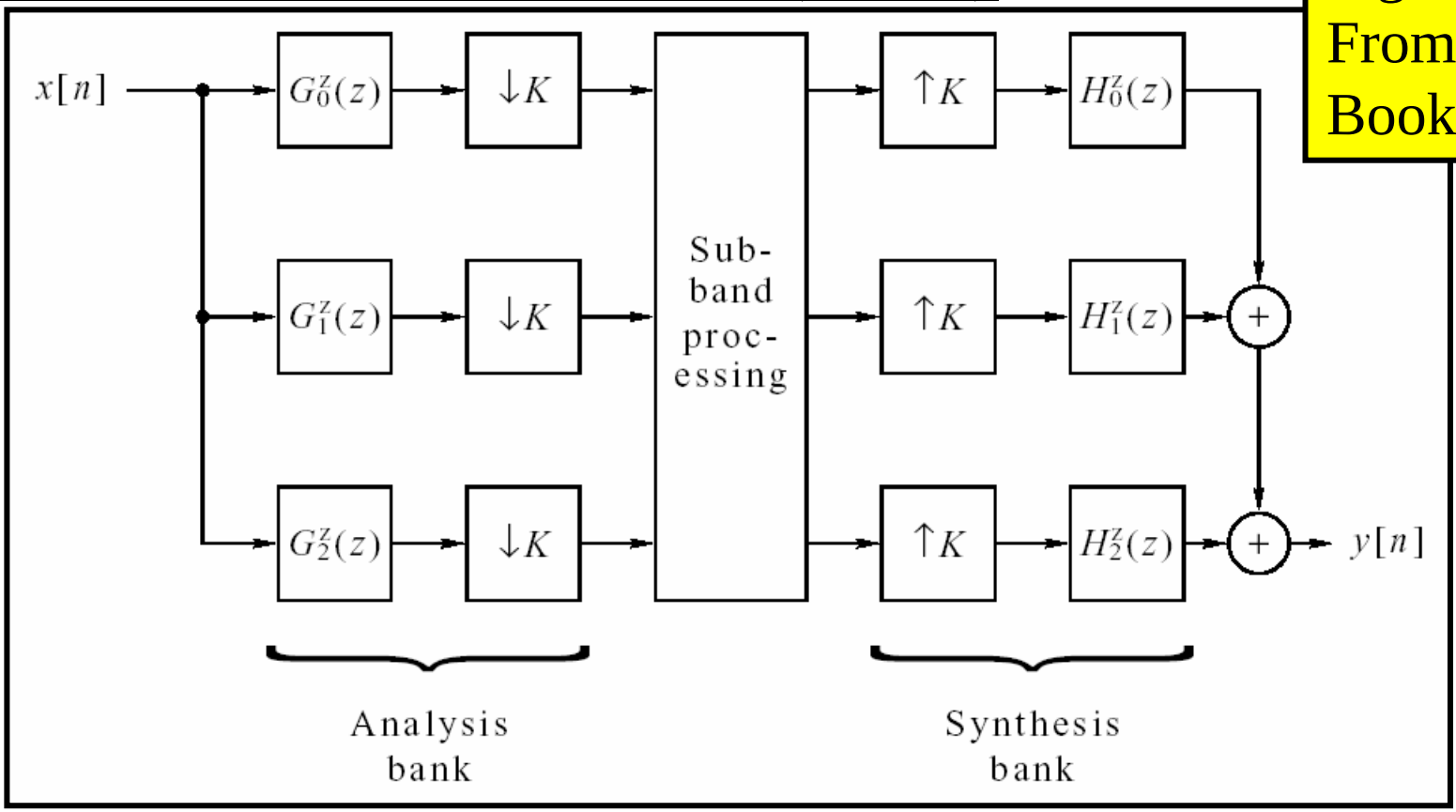
➔ Can Decimate Each Channel by M

Recall Cell Phone Basestation Example:



Decimated Filter Banks (cont.)

Fig. 12.26
From Porat's
Book



Necessary: Decimation Factor $K \leq M$ (M = # Channels)

If $K = M$, called a "Maximally Decimated Filter Bank"

Our Focus

Maximally Decimated FB's are the most computationally efficient

… but the filters must meet strict requirements.

➔ sometimes better to use $K < M$