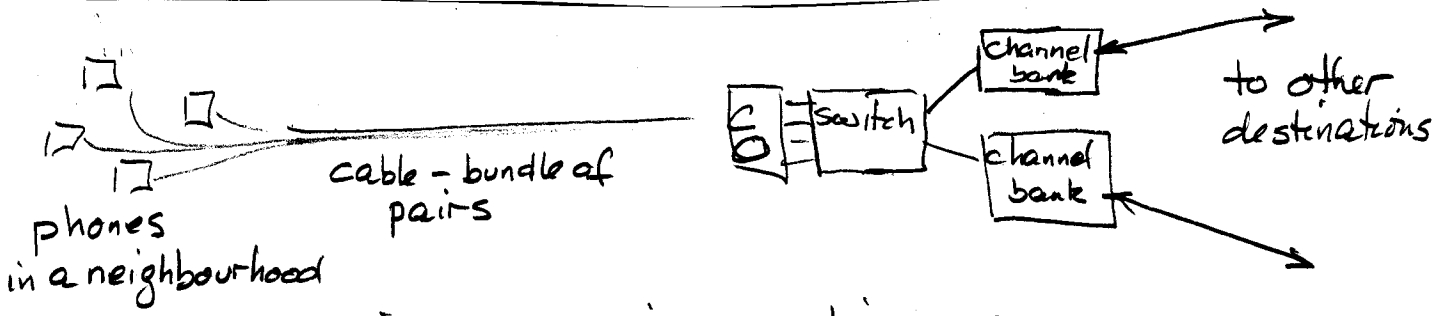
1.3 Representative Channels

- Here we will look at a few of the many types of link, and try to generalize issues from them

Telephone Channel

- analog channel, end to end, originally designed for analog voice.
- the original analog system in part:



- close proximity of pairs sometimes causes mutual interference (crosstalk)
- noise pickup on cable and on long links
- it looks like a filter

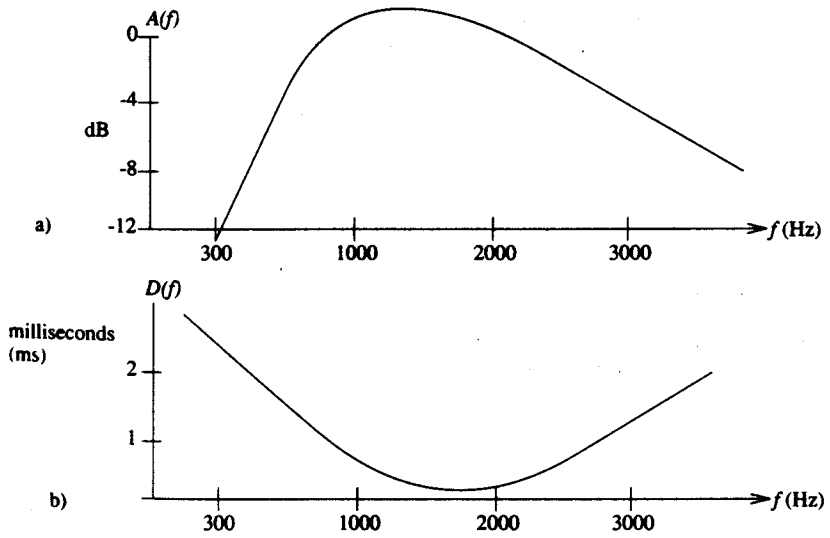


Fig. 1.21 Typical linear characteristics of a telephone channel. (a) Amplitude vs. frequency. (b) Envelope delay distortion vs. frequency.

- no dc
- no high frequencies

– the channel bank combines many signals on one link

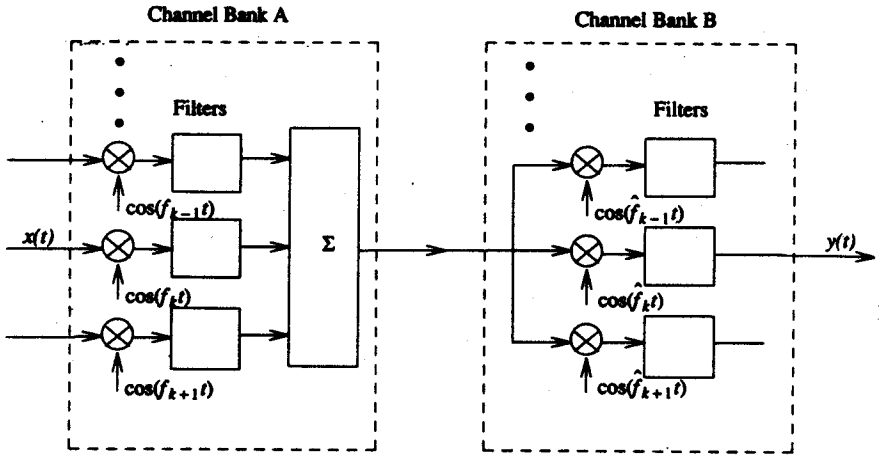
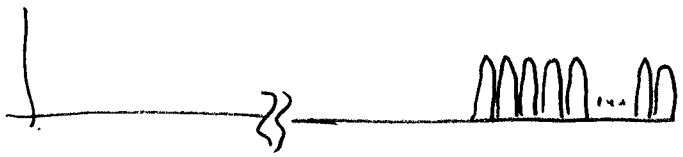


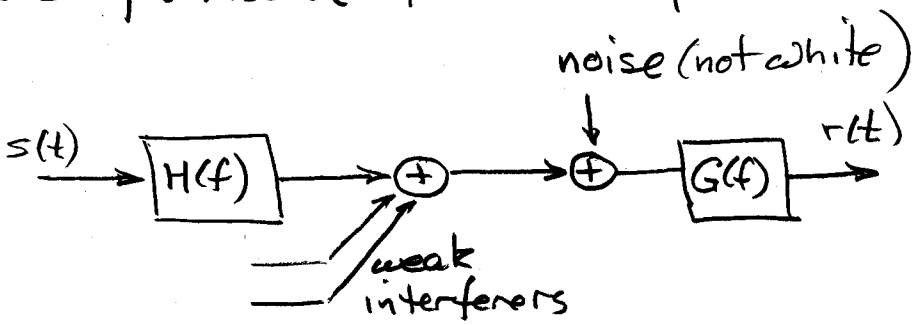
Fig. 1.23 Up- and down-modulation operations in FDM channel banks. The down-modulation reference frequencies $\{\hat{f}_k\}$ are ideally equal to the up-modulation frequencies $\{f_k\}$.

– SSB transmission of many signals

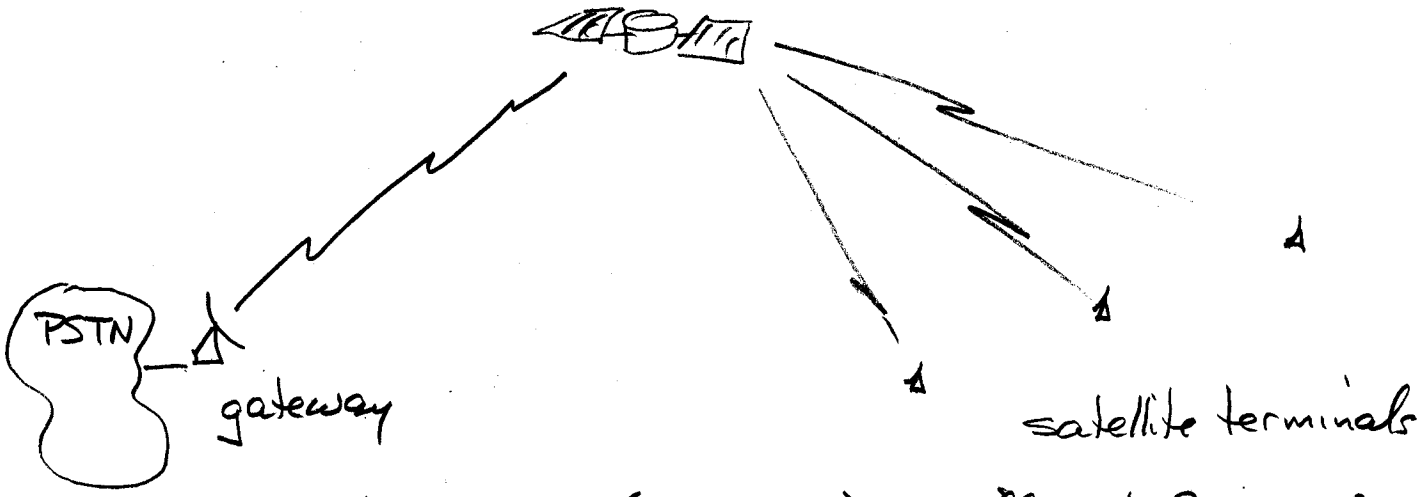


f

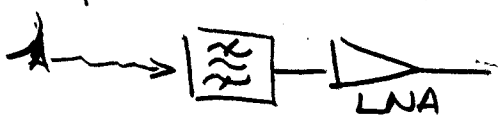
– a simple model of overall system



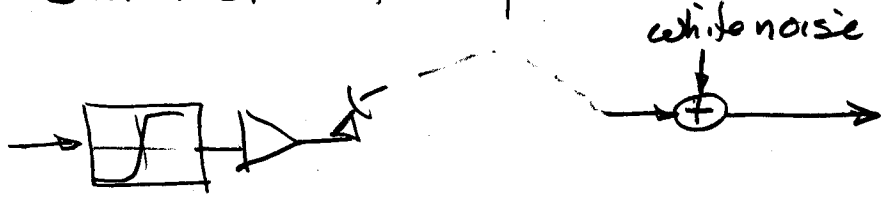
Satellite Channel



- satellite repeater (bentpipe), different frequencies up and down 4, 6 GHz or 12, 14 GHz typ
- lots of bandwidth – typ a MHz for each link
- FDM
- very little distortion from filters
- huge path loss, so signals near the noise level, even 1 dB improvement can save hundreds of millions of dollars
- most noise produced in receiver front ends, so expensive LNAs used

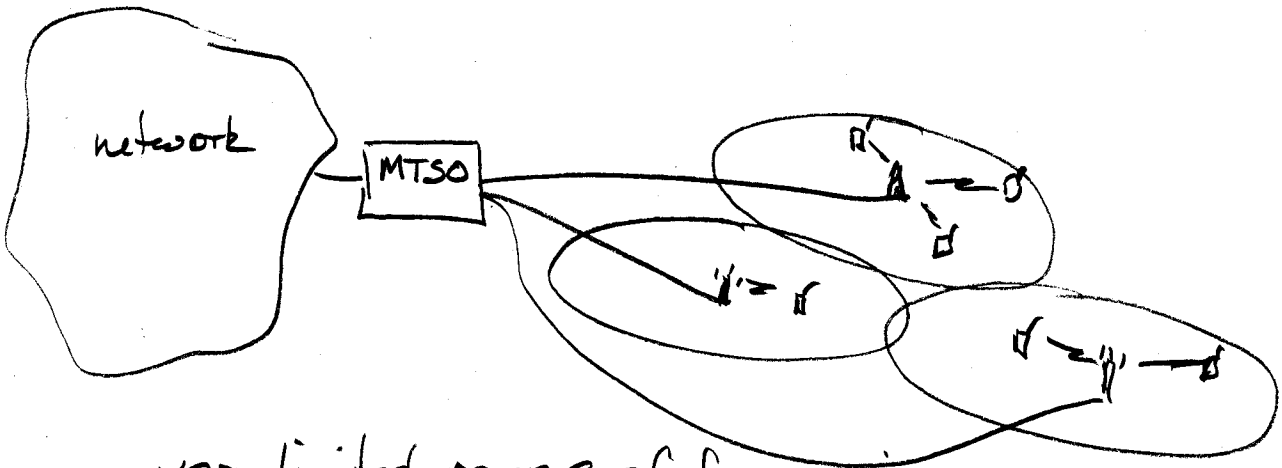


- very powerful amps (~500W) in transmitters, very expensive, nonlinear and run near saturation for power efficiency.



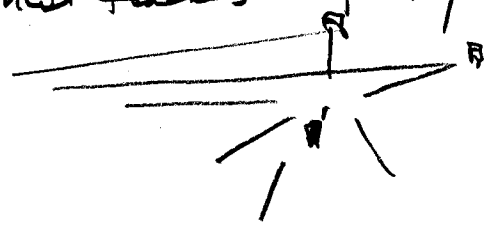
Personal (mobile) Communications

- geographic area divided into cells, each with a base station.



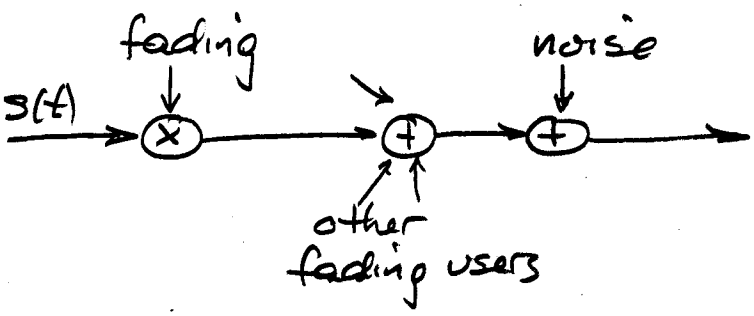
- very limited range of frequencies (a few tens of MHz for whole system)
- interference, more than noise, is the big problem: interference from other cells, interference within cell
- organised by FDMA, TDMA or CDMA

- signal fades rapidly because of scattering



motion of λ/4 or more, big change

-



1.4 Technical Issues

- bandwidth limits data rate
  - spectral efficiency bps/Hz

- using many levels to increase data rate makes signal increasingly vulnerable to noise and interference

  - power efficiency prob of transmit error as function of SNR

- the two efficiencies conflict

- nonlinear amplifiers distort signals, cause IM noise

- filters distort signals, garbling pulses together

- some signals fade in and out rapidly.

- etc

- clever solutions make money, improve infrastructure (and are fun to devise)