Satellite & Mobile Communication Network

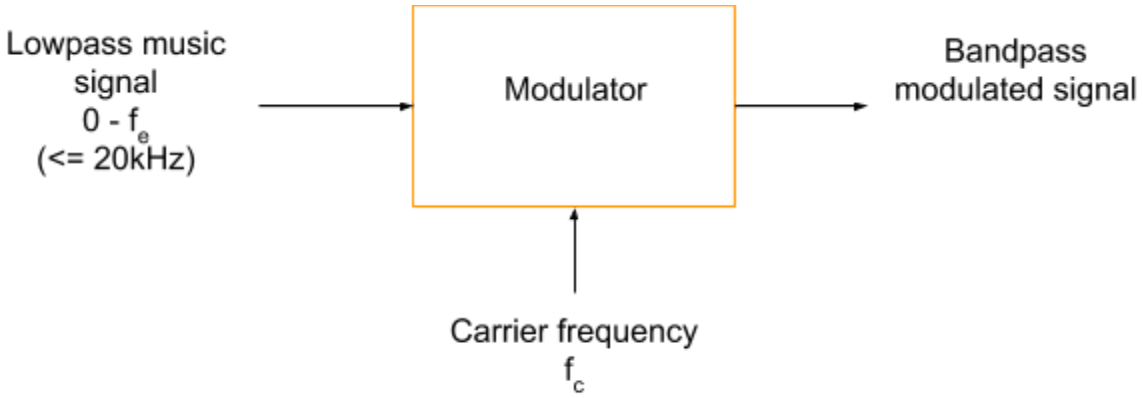
01.09.2020

1. Transmission over space:
    a. Analog signal transmission
        i. Analog voice
            1. Music (0 - 20kHz)
            2. Telephone (0 - 4kHz)
        ii. TV
            1. Video (0 - 5MHz)
            2. Audio (0 - 20kHz)
    b. Digital signal transmission : we'll do it later.
2. Analog music transmission over space :
   Say we have n number of sources:

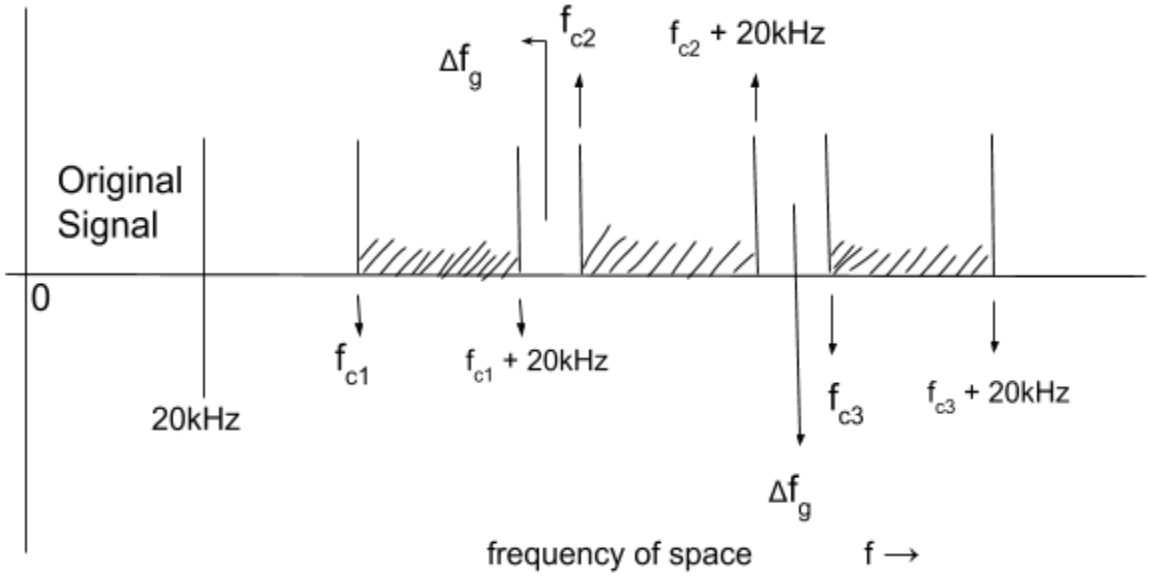
Sources	→	Bandwidth
S_1	→	0 - 20kHz
S_2	→	0 - 20kHz
.		
.		
.		
S_n	→	0 - 20kHz

Low Pass Signal

3. When all sources transmit their music signal, all will collide in the space.
4. Signals
    a. Lowpass (music) → 0 - f_e
    b. Bandpass (modulated signal) → f_L - f_H
    c. Highpass → f_H - ∞ [no relevance]
5. Solution:



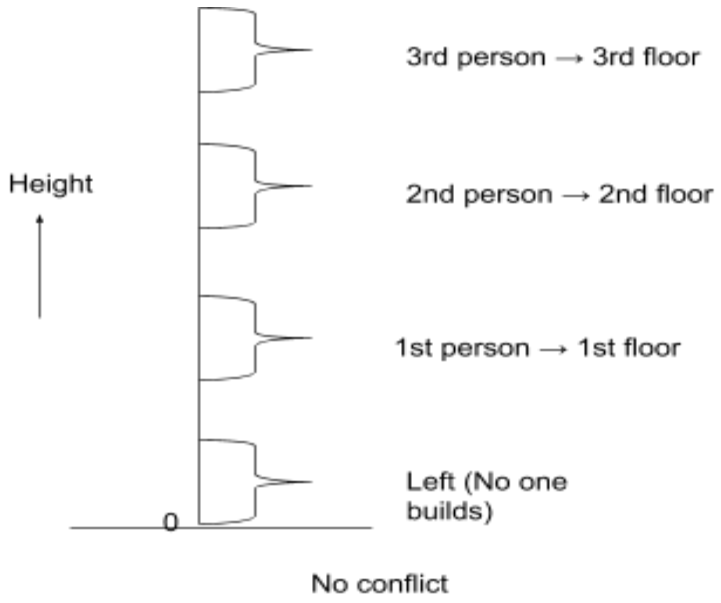
6. Modulation types
    a. Amplitude Modulation (AM)
    b. Frequency Modulation (FM)
    c. Phase Modulation (PM) [not used]
7. Amplitude modulated music:
    a. Bandpass signal: $f_c \rightarrow f_c$ + 20kHz, bandwidth of each channel
    b. 0 ⟶ 20kHz lowpass signal is transformed to f_c to f_c + 20kHz bandpass signal.
8. Frequency modulation :
    a. 0 ⟶ 20kHz lowpass signal is transformed to f_c to f_c + 5x20kHz bandpass signal by frequency modulation.
9. Frequency Division Multiplexing in AM music transmission



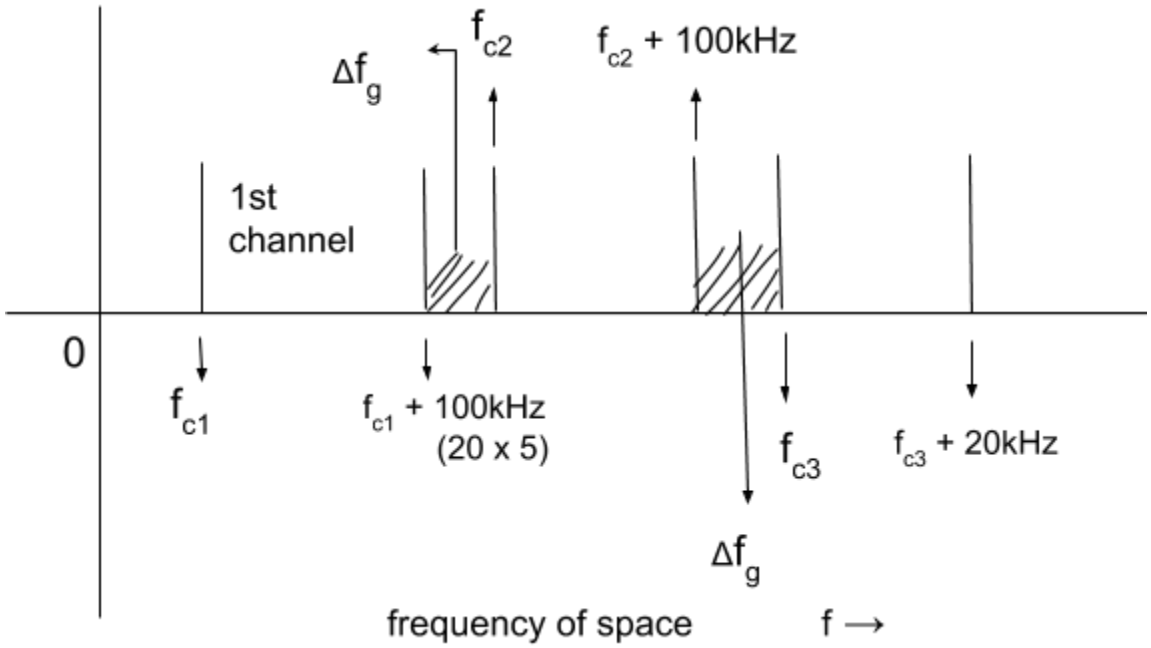
$$f_{c2} = f_{c1} + 20\,kHz + \Delta f_g$$
$$f_{c3} = f_{c2} + 20\,kHz + \Delta f_g$$

Δf_g = guard band to stop interference between two consecutive channels

10. Each low pass music signal (0 - 20 kHz) ⇒ Band pass music signal ($f_c \rightarrow f_c$ + 20 kHz by modulation)
11. House building analogy with modulation
    a. One piece of land on the ground floor. N number of parties want to build on ground floor ⇒ conflict
    b. Each builds their house in multistoried fashion leaving ground floor

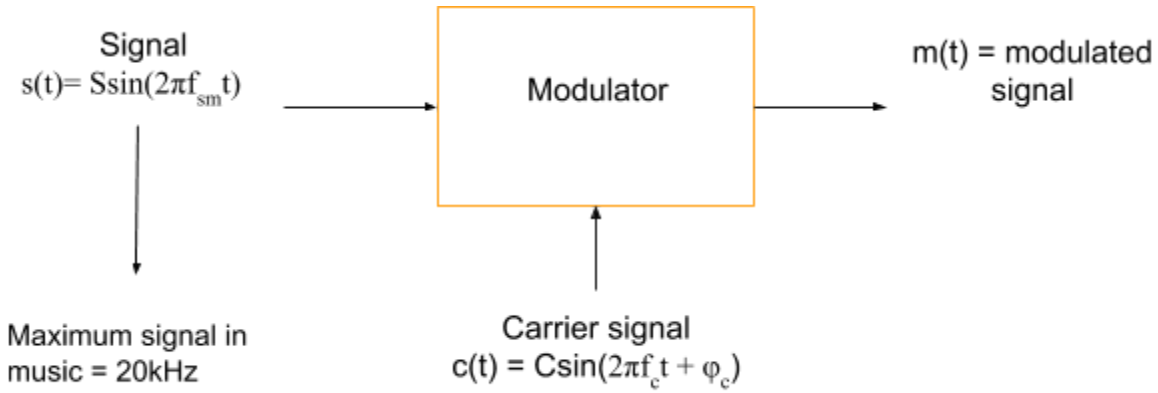


12. Frequency Division Multiplexing (FDM) for Frequency Modulation



$$f_{c2} = f_{c1} + 100\,kHz\,(5 * 20) + \Delta f_g$$
$$f_{c3} = f_{c2} + 100\,kHz + \Delta f_g$$

13.



14. Amplitude Modulation

$$m(t) = (C + k_a s(t)) \sin(2\pi f_c t + \phi_c)$$

15. Frequency Modulation

$$m(t) = C\sin(2\pi(f_c + k_f s(t))t + \phi_c)$$

C and ϕ_c are constant, f_c varies

16. Phase Modulation

$$m(t) = C\sin(2\pi f_c t + (\phi_c + k_p s(t)))$$

C and f_c are constant, ϕ_c varies

k_a = proportional constant for amplitude modulation

k_f = proportional constant for frequency modulation

k_p = proportional constant for phase modulation