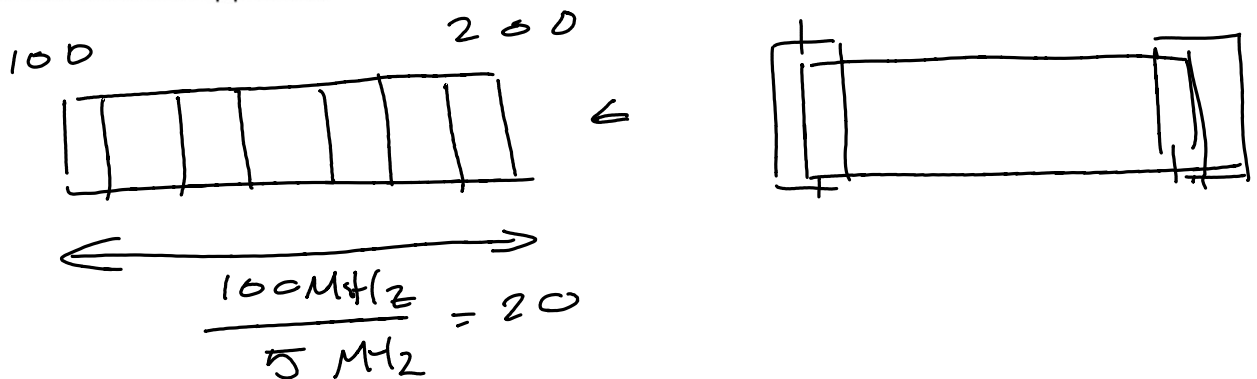


## Duplexing and Multiple-Access Techniques

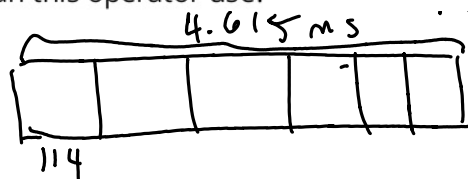
**Exercise 1:** Is a normal phone call half-duplex, full-duplex or simplex? How about a radio broadcast? A typical police dispatch radio using push-to-talk (PTT)?

phone: full duplex  
 radio: simplex  
 PTT dispatch: half-duplex

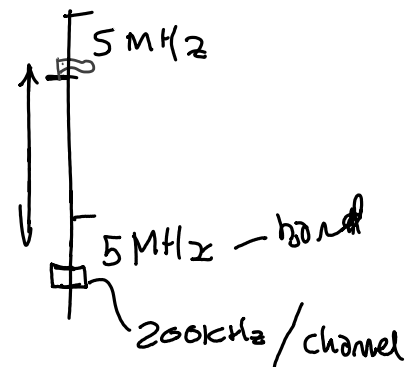
**Exercise 2:** A cable TV system uses frequencies between 100 and 200 MHz and channels are spaced 5 MHz apart. How many simultaneous users can be supported?



**Exercise 3:** GSM cellular systems use FDD and TDMA. Each user gets to transmit 114 bits in one of eight "slots" per frame and each frame lasts 4.615 ms long. What is the average data rate for each user? GSM channels are spaced every 200 kHz. An operator has one 5 MHz frequency allocation for each direction ("paired" spectrum). How many channels can this operator use?



$$\text{bit rate} = \frac{114}{4.615 \text{ ms}} = 24.7 \text{ kb/s}$$



$$\# \text{ channels} = \frac{5 \times 10^6}{200 \times 10^3} = \underline{25 \text{ channels}}$$

$$\# \text{ users} = 8 \times 25 = 200 \text{ users}$$