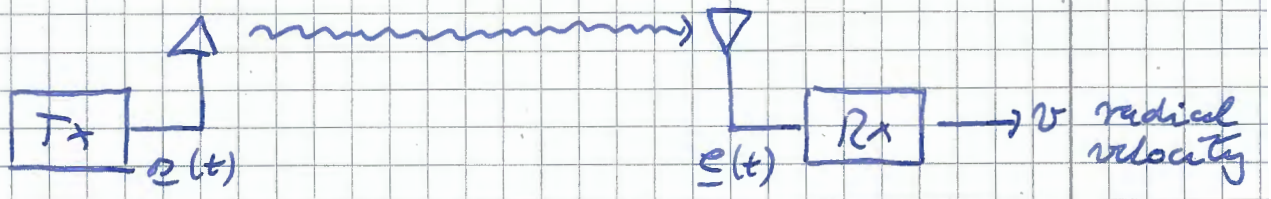
Velocity Estimation

One Way Channel (Radio Navigation)



- wavenumber $\beta = \frac{2\pi}{\lambda} = \frac{\omega_0}{c_0}$
- Doppler frequency $\Delta\omega = -\frac{v}{c_0}\omega_0 = -\beta v$
  $\Rightarrow$ Doppler frequency and velocity domain are the same except for a scaling by $-\beta$
- received signal

  unknown complex factor incorporating attenuations and phase shifts

$$\underline{E}(\omega) = \underline{c}\,\underline{S}(\omega - \Delta\omega) + \underline{N}(\omega)$$

$$\underline{e}(t) = \underline{c}\,\underline{s}(t)\,e^{j\Delta\omega t} + \underline{n}(t)$$

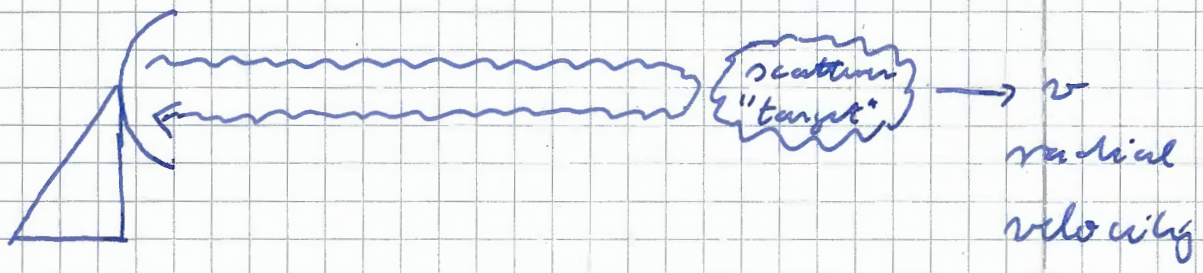
- velocity estimation is a harmonic retrieval problem (dual to range estimation)
- velocity resolution $= \frac{1}{\beta}$ (one way channel) frequency resolution

$$\approx \frac{1}{\beta}\,\frac{2\pi}{\text{duration}}$$

(due to duality)

$$= \frac{\lambda}{\text{duration}}$$

Two Way Channel



- Doppler frequency $\Delta\omega = -2\beta v$

  $\Rightarrow$ Doppler frequency and velocity domain are the same except for a scaling by -2β.

  $\Rightarrow$ The only difference to velocity estimation in the one way channel is a factor of 2.