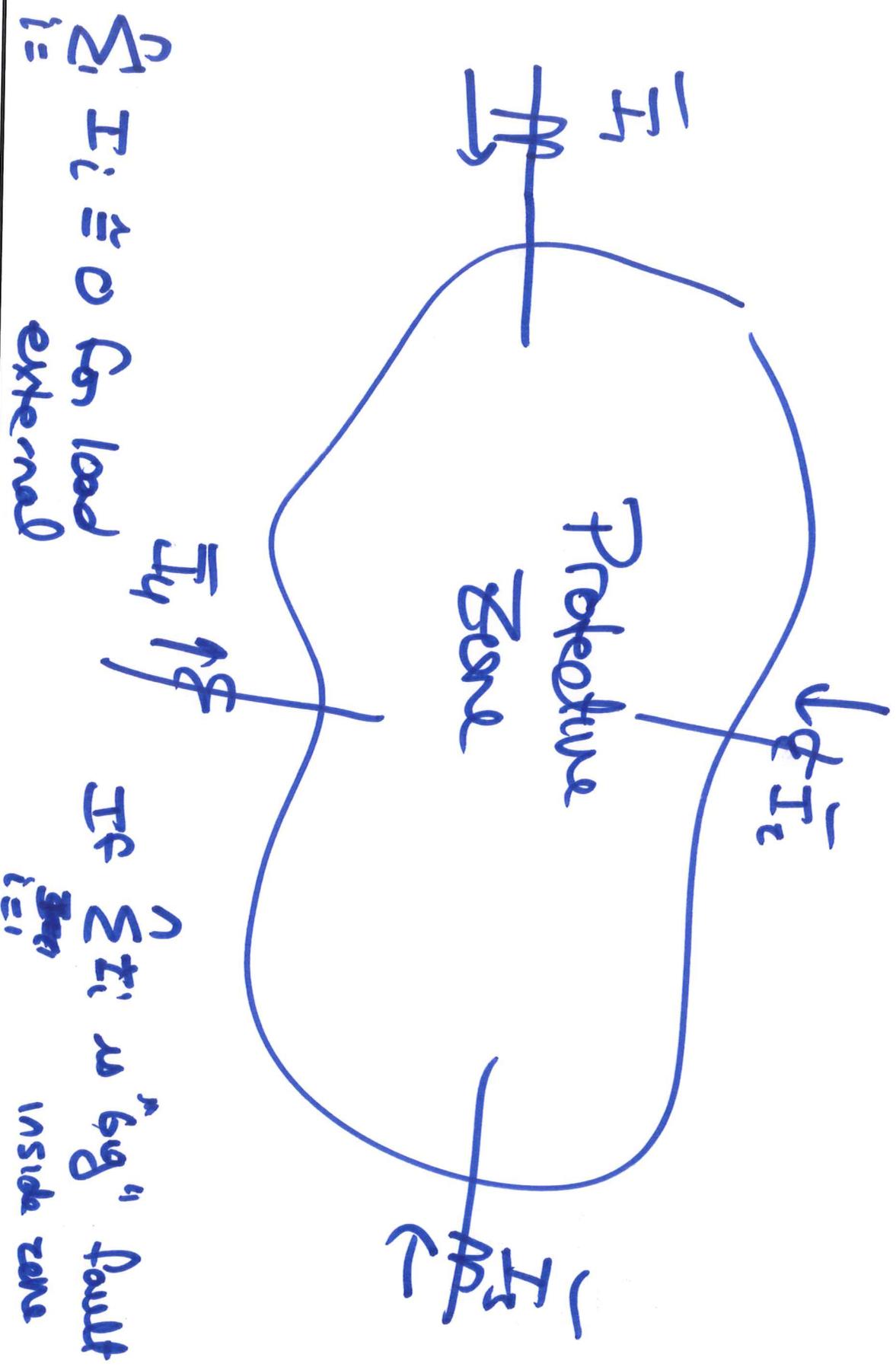


ECE 526

PROTECTION OF
POWER SYSTEMS II

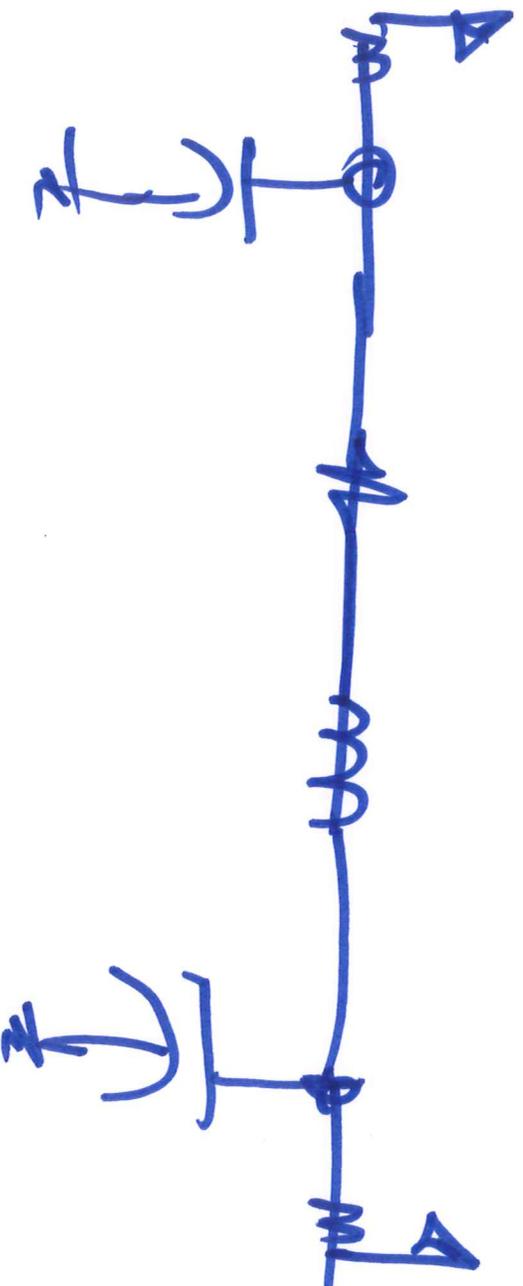
SESSION no. 12

Line Current Differential Protection



Transmission line case - (challenges)

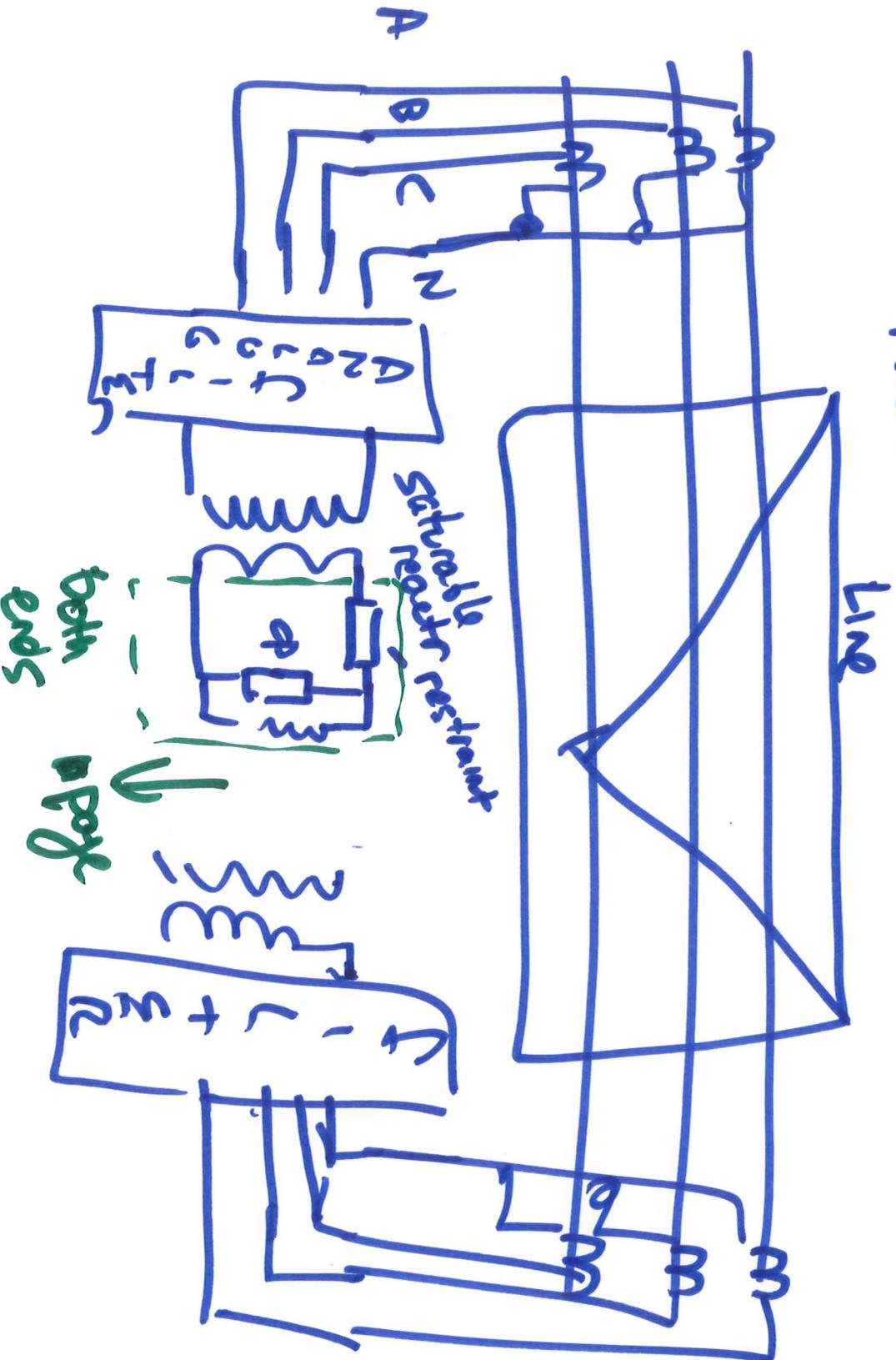
- No longer have relays close together
- communication
- Longer vs shorter lines
 - charging current
 - communication delay

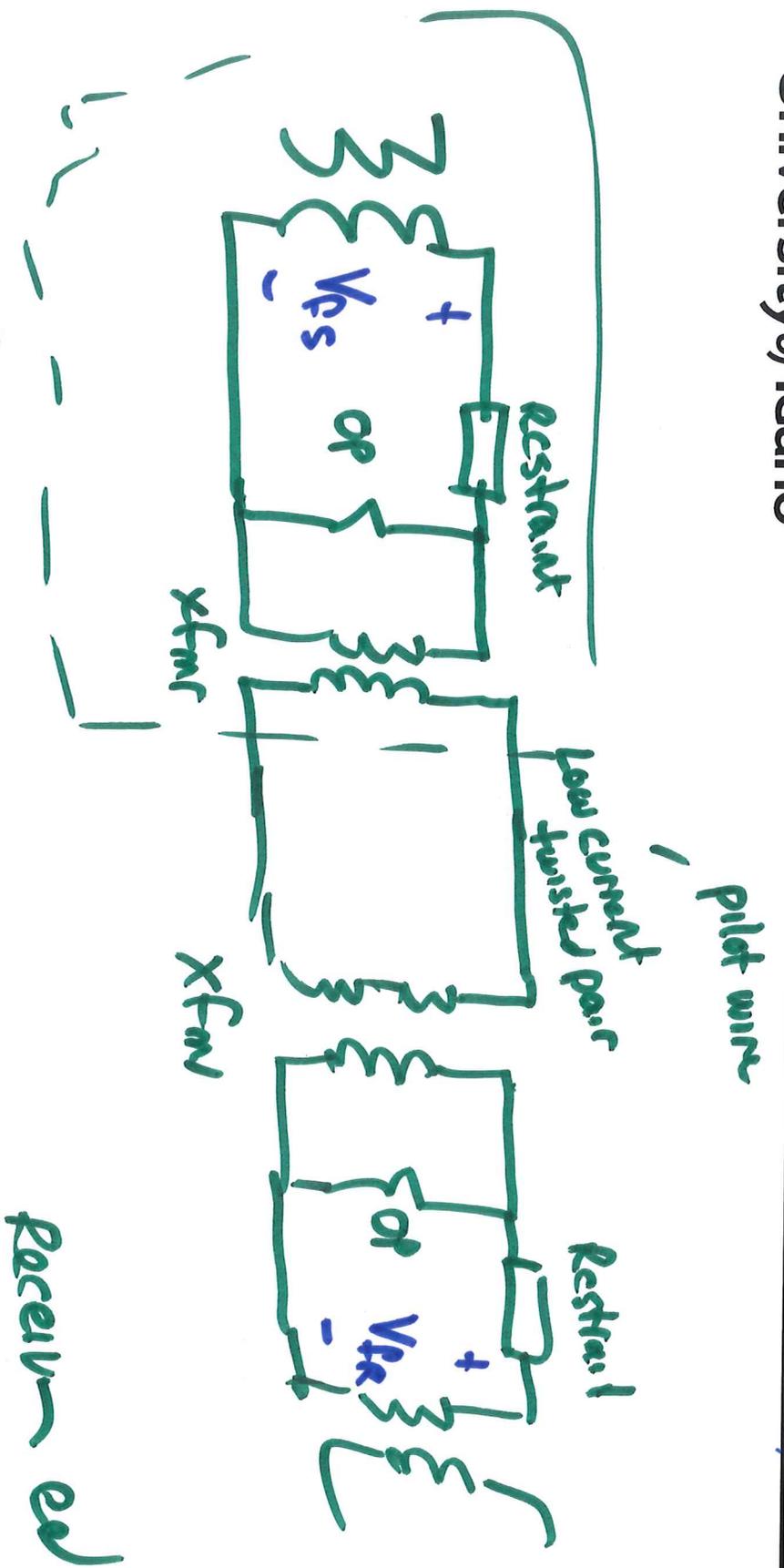


- know approx charging current
- offset term

Electromechanical Relays

- Pilot Wire Schemes





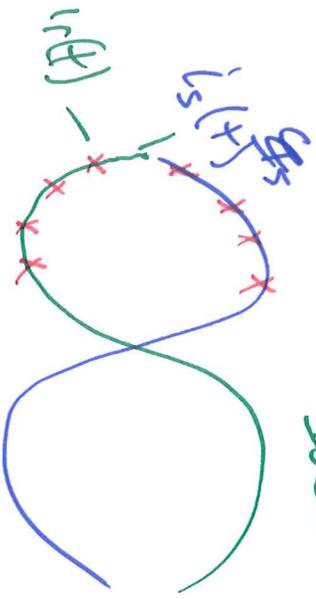
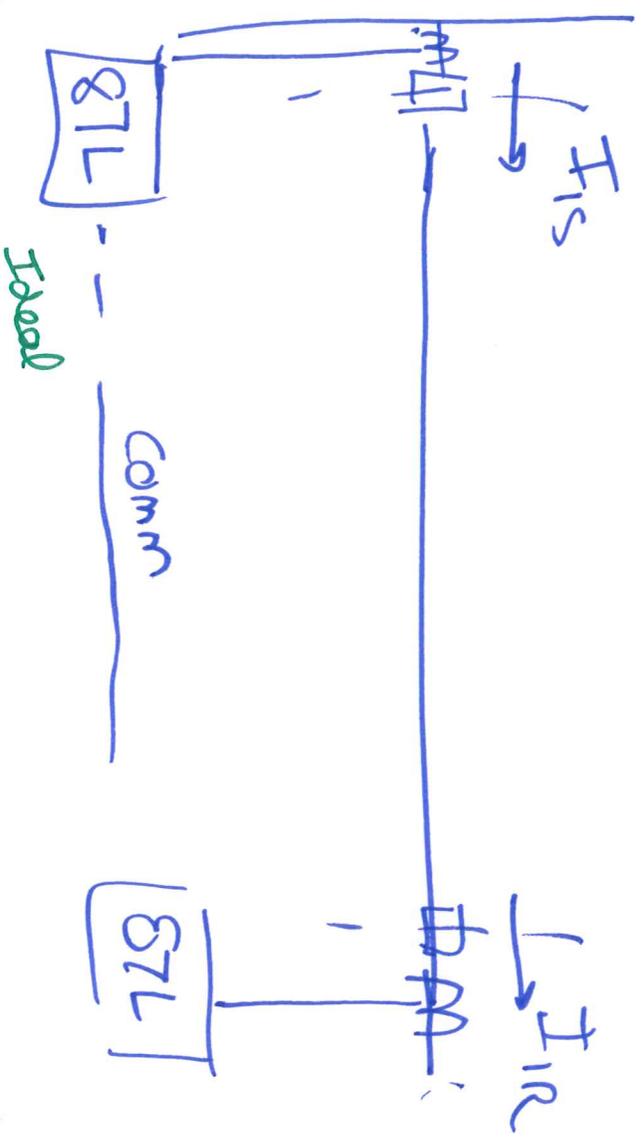
$$V_{fs} = 2 I_{f1} R_1 + I_{f0} (R_1 + 3Z_0)$$

Load on External fault $V_{fs} \approx -V_{fr}$

Internal fault $V_{fs} \approx V_{fr}$

Modern schemes

- digitize local currents
- & communicate to remote end

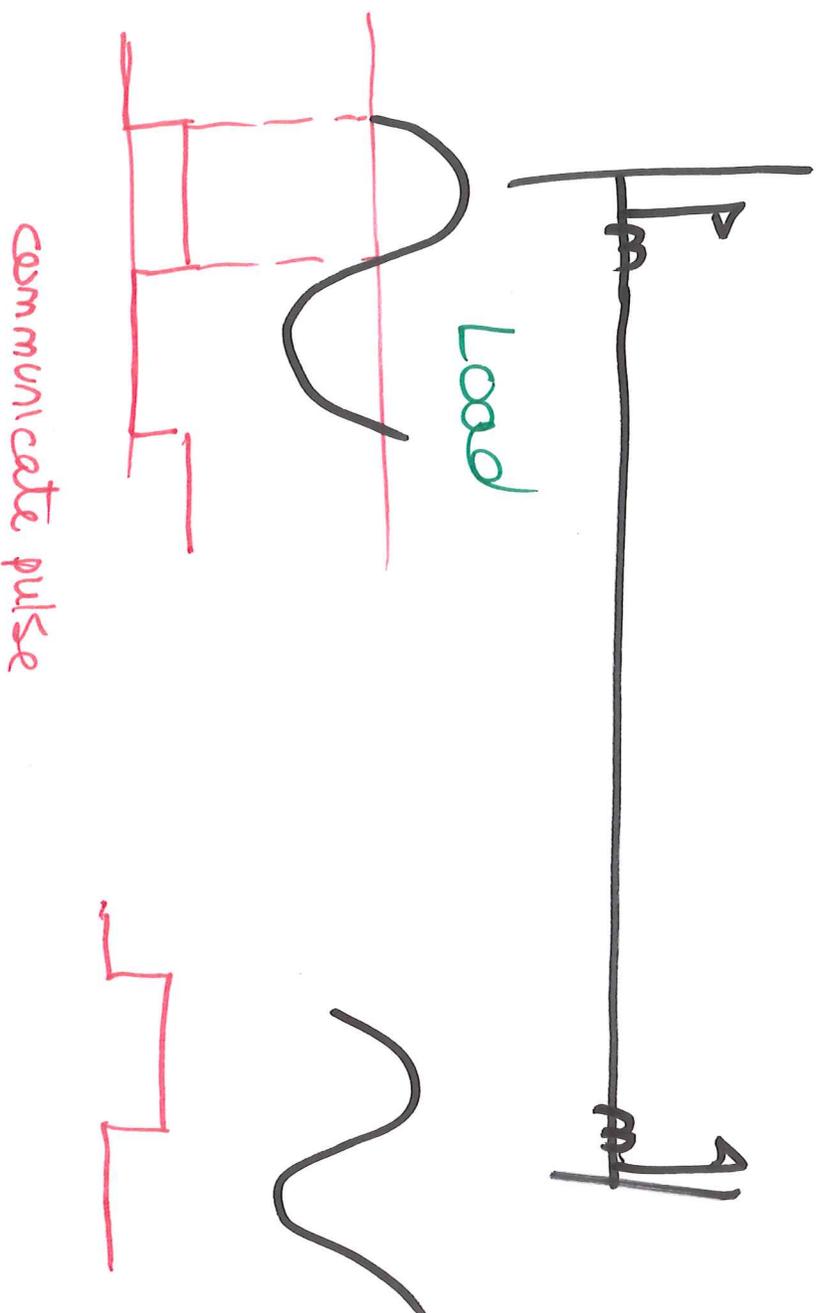


- Time align the data
- phase data - processed

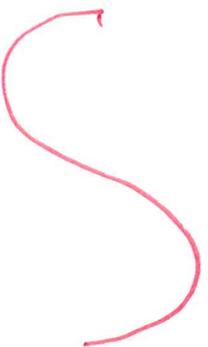
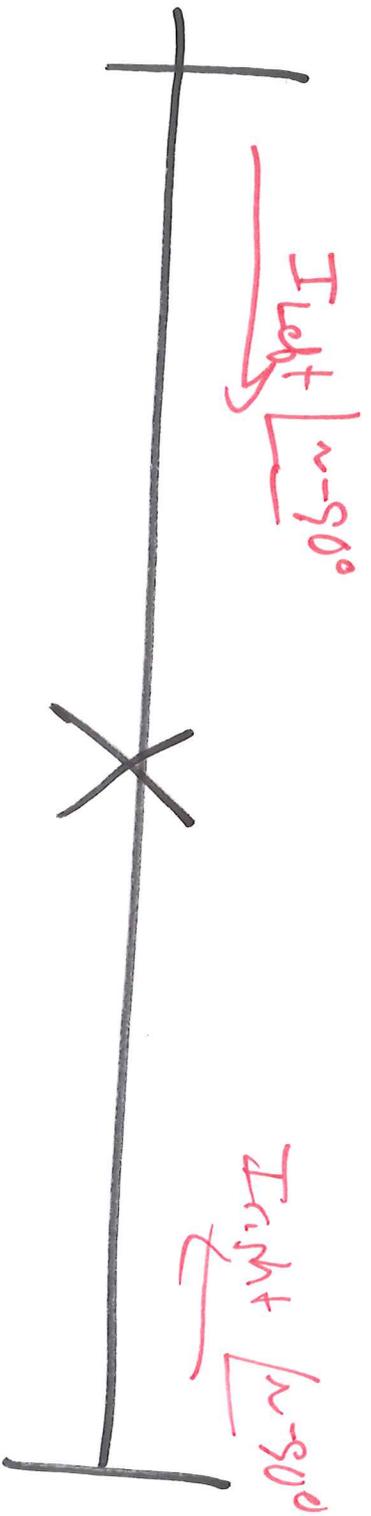
Possible Protection Schemes

1. Phase comparison

- lower communication bandwidth



- even with power line carrier



Comms



- harder to use for longer lines
- each relay makes own decision

Percentage Differential

- each relay ~~transmits~~ transmits
- Info for filtered $\bar{I}_A, \bar{I}_B, \bar{I}_C$
- Time alignment

- digital comm channels

- GPS - other common clock (send time stamp)

- more common is calculate channel delay & keep ~~update~~ updating

asymmetric channels a problem

- Ping pong signal - send signal with immediate retransmit
- divide by 2

$$\hat{I}_{op} = \left| \sum (\hat{I}_1 + \hat{I}_2 + \dots) \right|$$

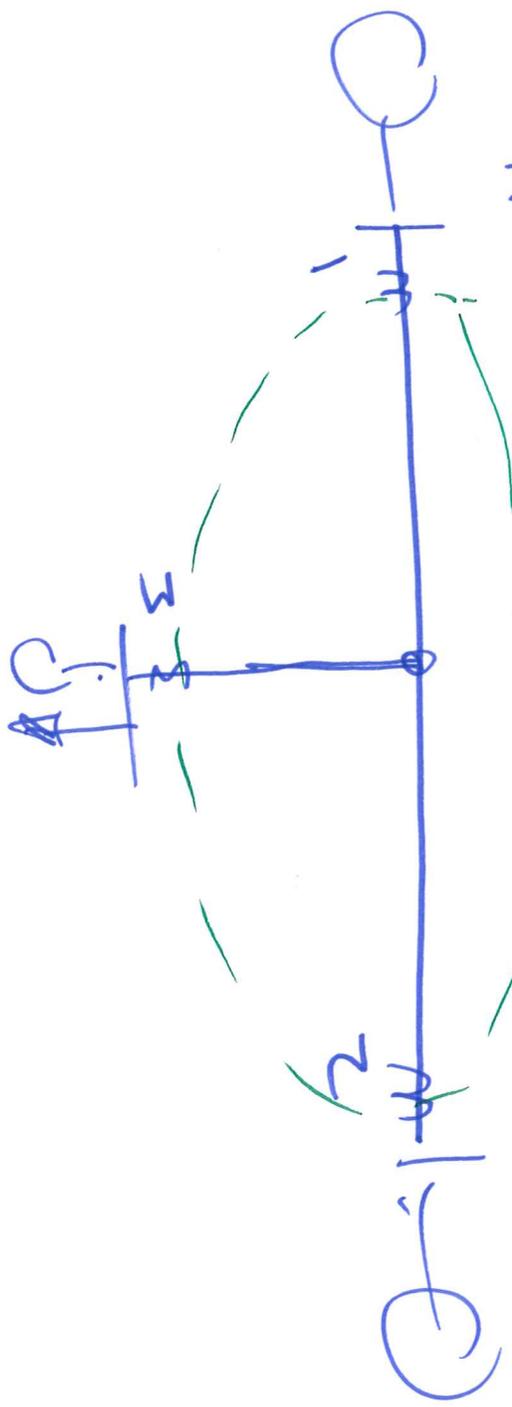
Low Impedance
Difference

$$I_{EST} = k \left(\sum (|I_1| + |I_2| + \dots) \right) \quad k = 1 \text{ or } 1/2$$

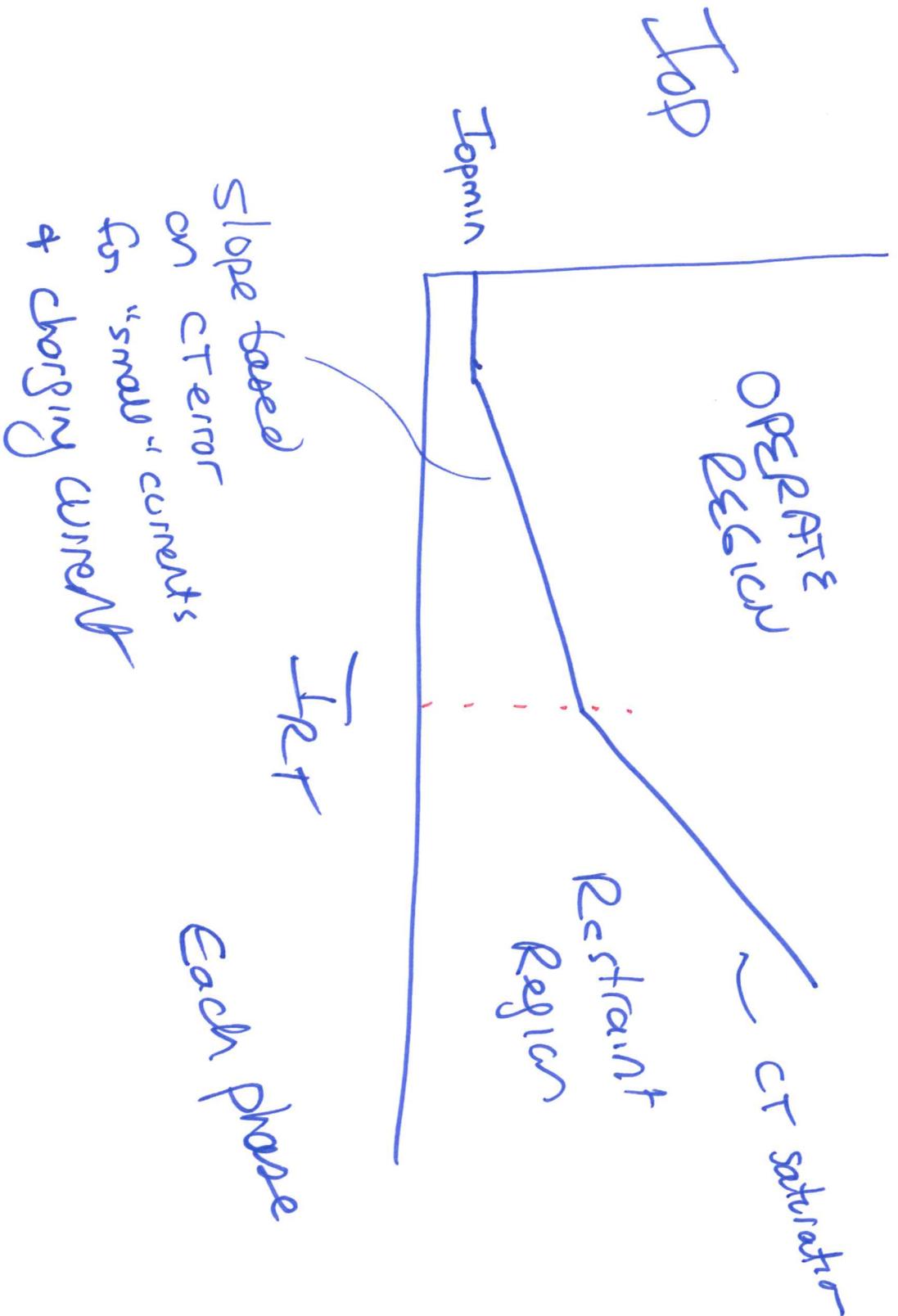
or = $k \cdot \text{MAX} (|I_1|, |I_2|, |I_3|, \dots)$

$$s_n = (\hat{I}_1 - \hat{I}_2)$$

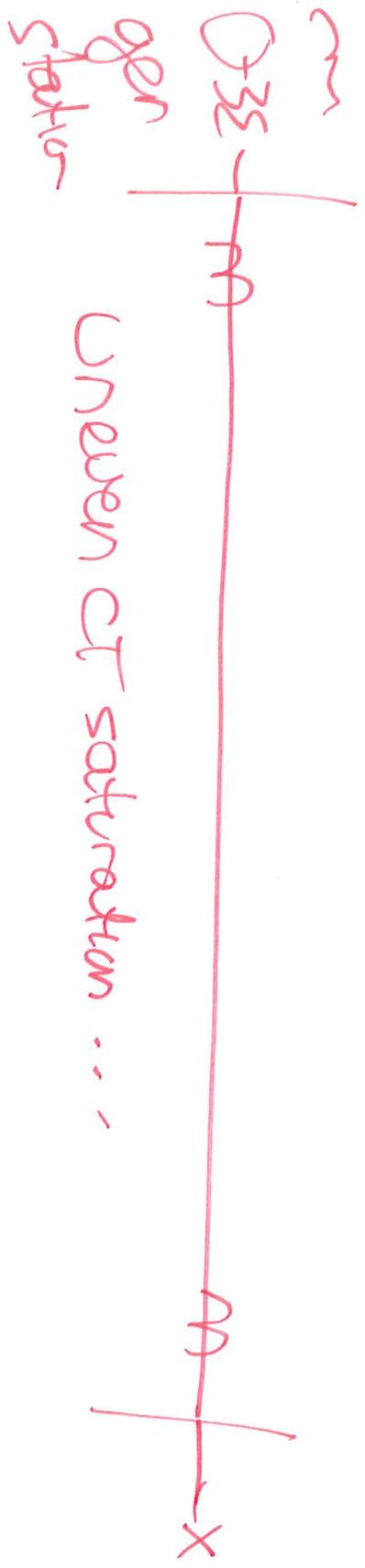
Tapped lines zone



differ by vendor



high H_e - long decay of DC offset



Alternating current differential

Implementation

$$\frac{\underline{I}_R}{\underline{I}_S} = \underline{\alpha} = a \angle \theta$$

magnitude and
angle

α -plane based scheme.

