

# differential relay

- no coordination
- only one equipment

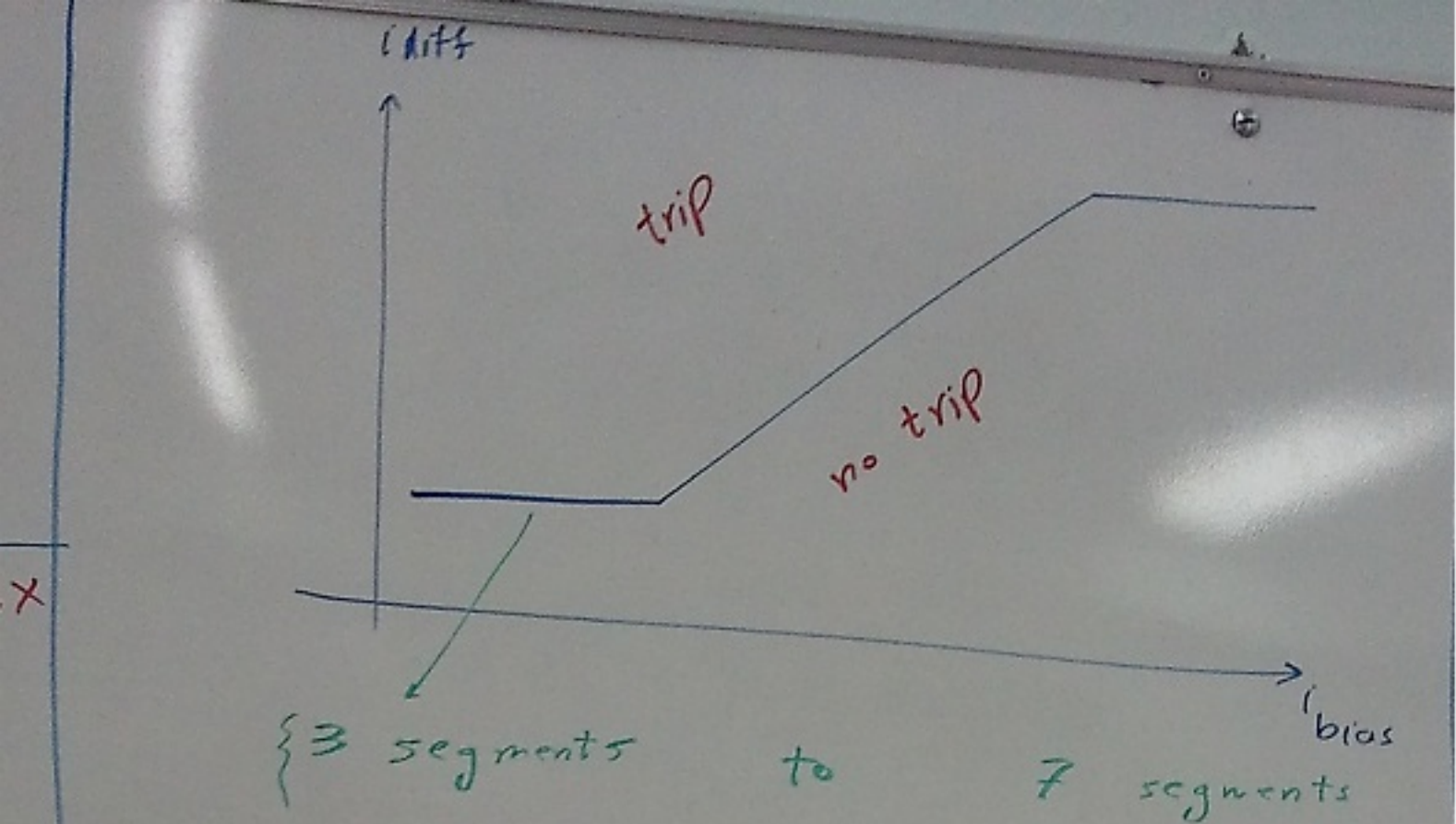


$$\text{bias} : \frac{|I_1 + I_2|}{2}$$

{  $N$  : bias winding  
analog

$$\text{diff} : \begin{cases} |I_1 - I_2| \checkmark \\ |I_1| - |I_2| \\ |\angle I_1 - \angle I_2| \end{cases}$$

← the various type of differential relays



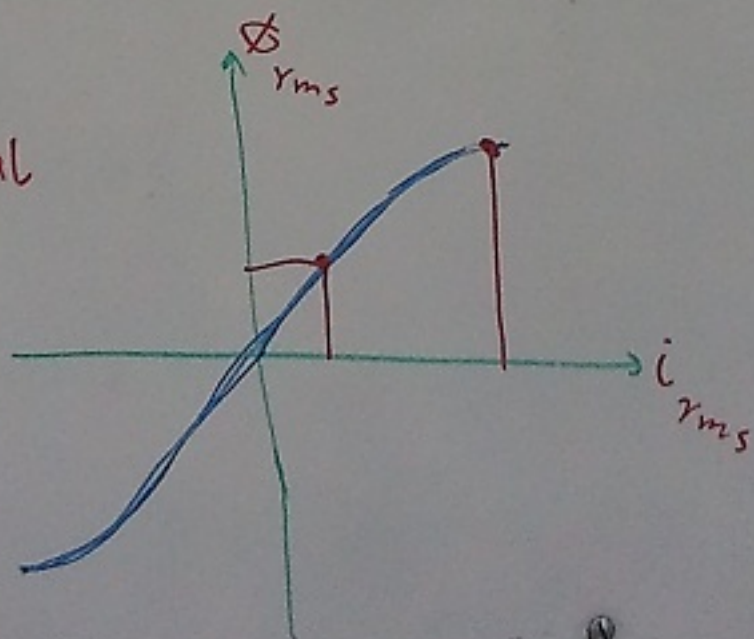
### CT Saturation:

$f_{aut}$ 

- out of protection zone:
  - bias prevents from sending trip
- in the protection zone:
  - bias X
  - diff ✓

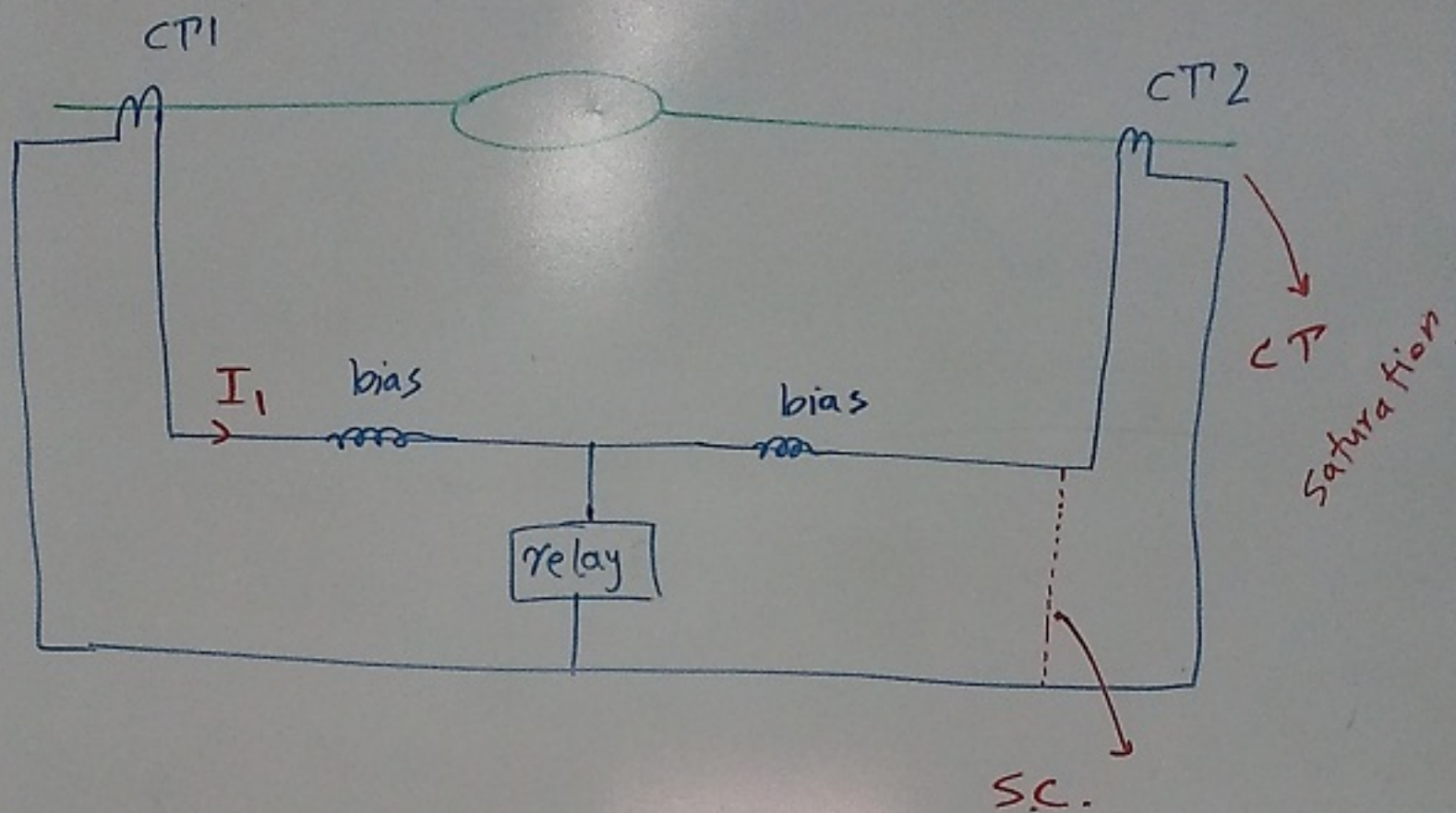
transmission line current  $\Rightarrow$

$\phi, i$ : sinusoidal





## modeling of CT saturation:



in saturation condition,

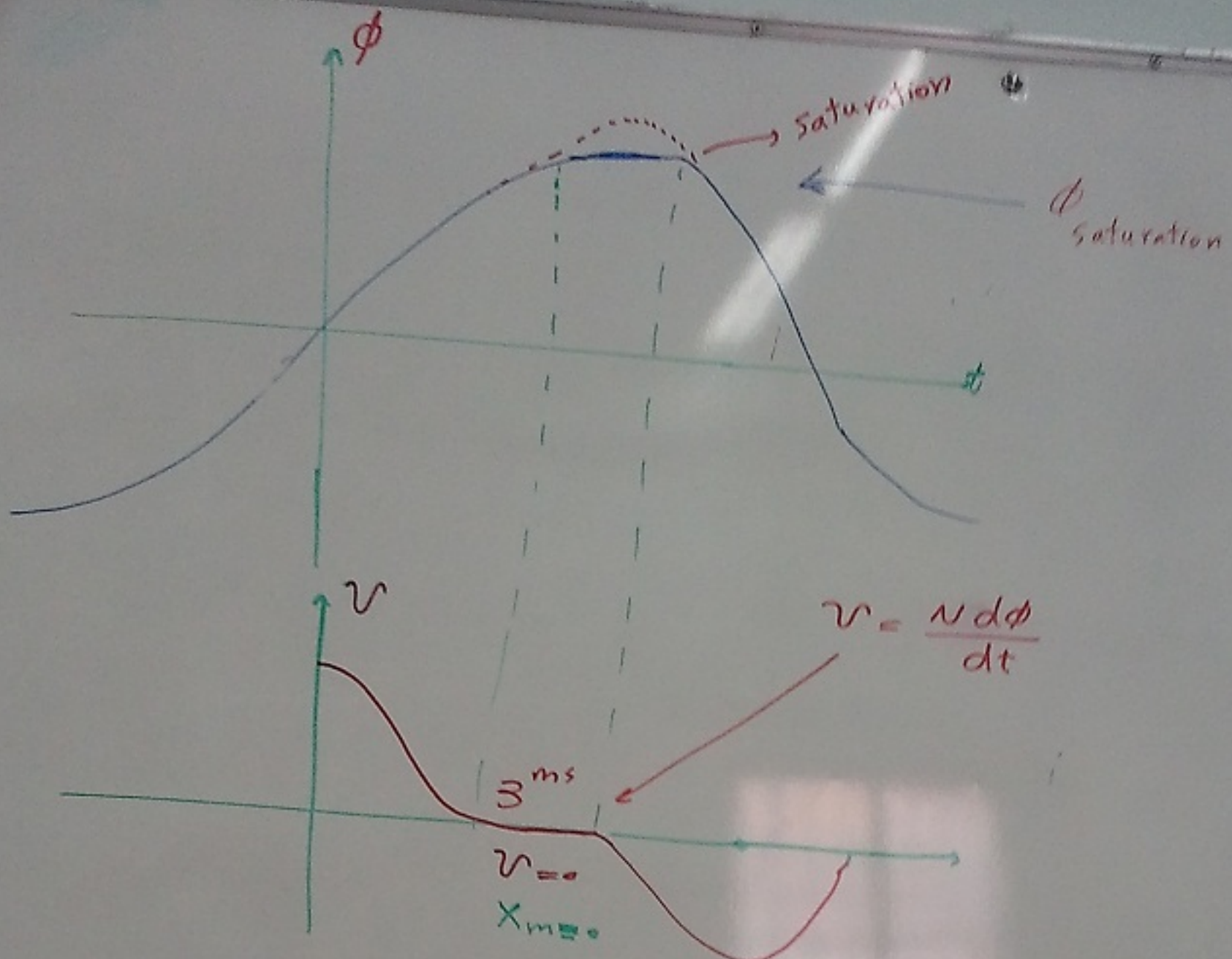
$i_{bias}$ ,  $i_{diff}$  is calculated.

respect to trip graph of differential

relay, it is determined that the relay

send a trip or not.





during saturation, voltage is equal to zero

maximum error is when ( $v=0$ ). (time  $\approx 3 \text{ ms}$ )

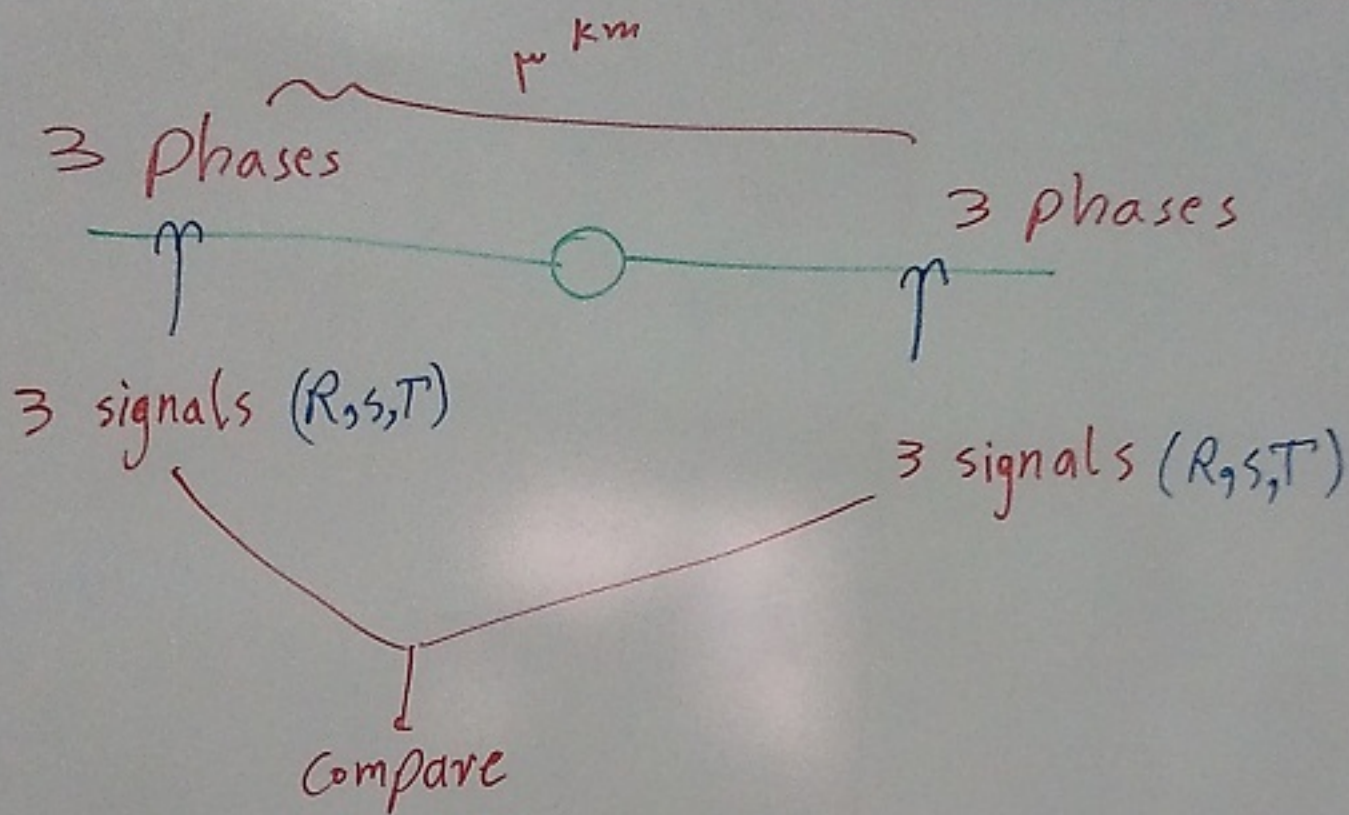
(it is enough to send a trip (operating time of differential relay) is instantaneous)



data communication: (smart grid)

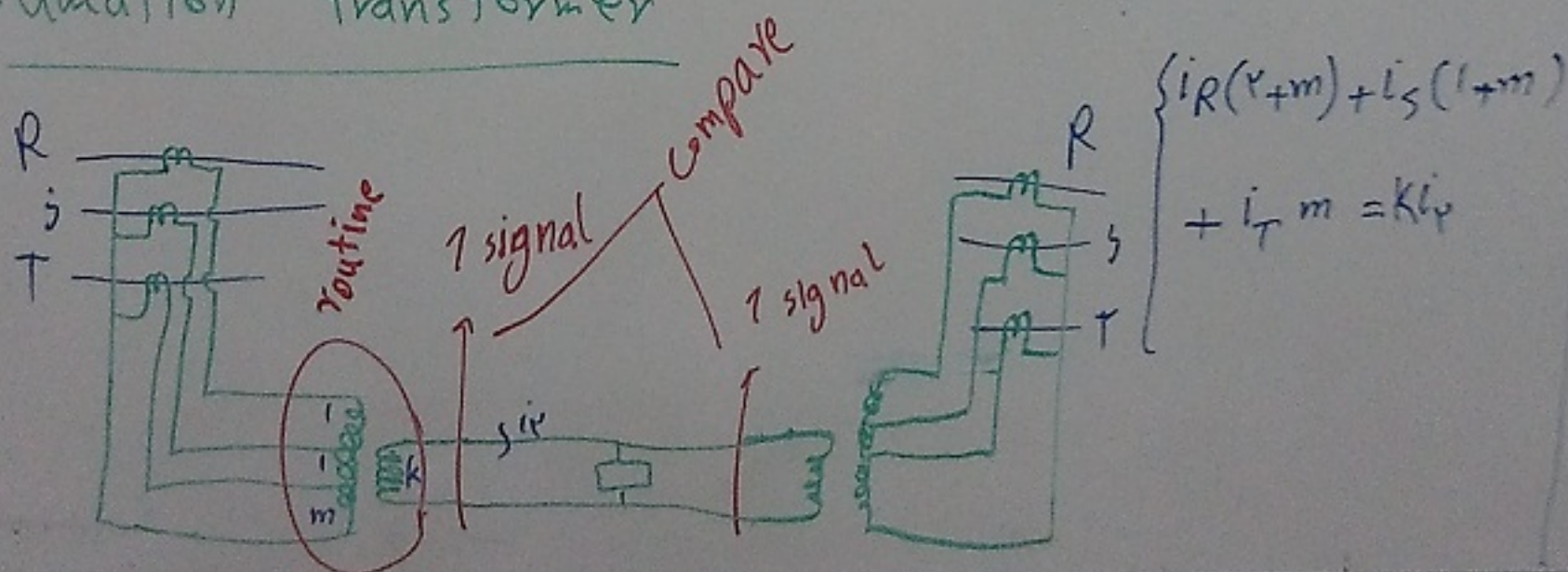
the most important issue is reliability.

private network



goal: { decreasing the number of signals  $\implies$   
reliability rising

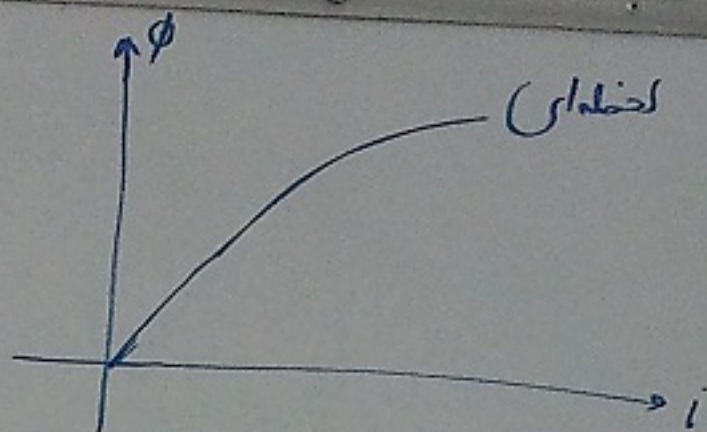
Sumation transformer





# inrush current:

1) saturation



$$v = N \frac{d\phi}{dt} \Rightarrow \phi = \frac{1}{N} \int v dt$$

