04/05/2014

DEMAND-SIDE CONTROL (DSC)

http://www.cigre.org.br/archives/pptcigre/03_control_of_active_power_&_frequency.ppt
http://www.der-lab.net/downloads/phd11_03_applications_of_luo.pdf

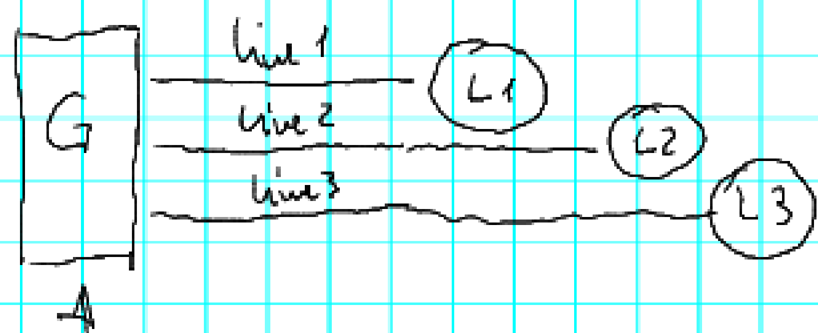
http://users.ece.utexas.edu/~kwasinski/EE394J10opcont.ppt
http://www.nist.gov/pml/high_megawatt/upload/Casey.pdf

CAVEAT #1 unreviewed material !
CAVEAT #2 just the high-level scenario & some examples...

DSC : (also) the loads act to control the network (basically, for us, Frequency)

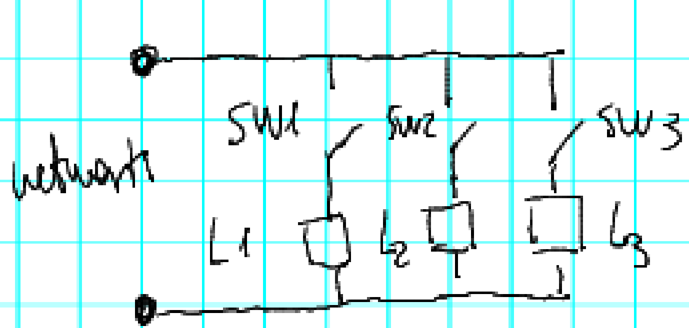
A generator can be configured to shed some loads under certain frequency conditions

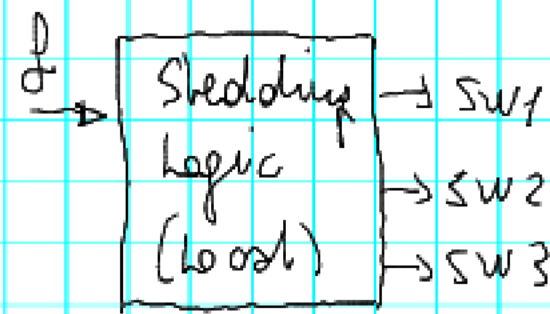
However this is not very practical



This can shed progressively, but each load needs connecting to the proper line

One can do the same at the load level



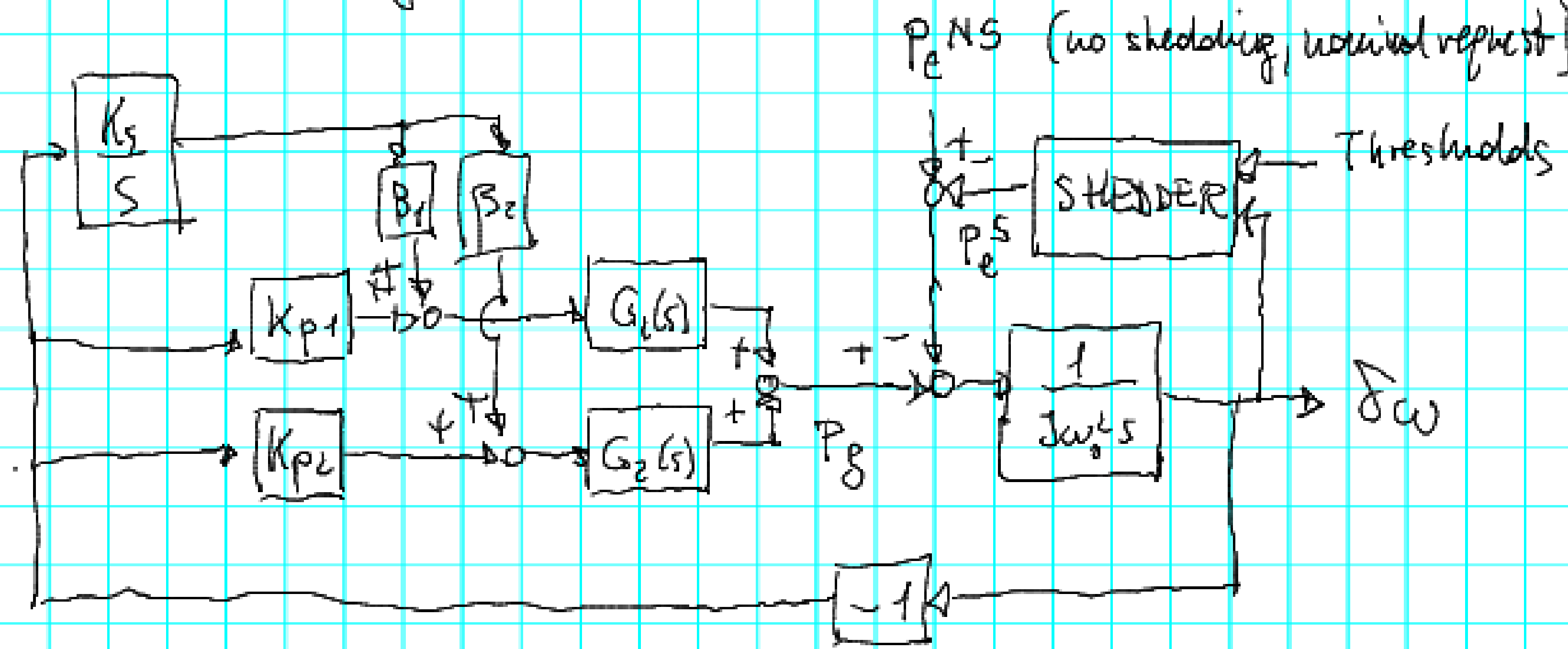


PRO : decentralised (1 line from network to load)

CON : the characteristics of local logics need stipulating thoroughly

NOTE : logic may be dynamic, e.g. shed in f below $\bar{f}$ for a time longer than $\bar{t}$...

Effect on P/f control at the network level



NOTE: with this we describe/simulate HOW MUCH of the load is rejected by shedding, not WHICH loads

Main problems

1) Decide how the combined effect of local shedders has to show up at the network level

   Frequency requirements ⇒ equivalent network-level frequency thresholds (and intervention times)

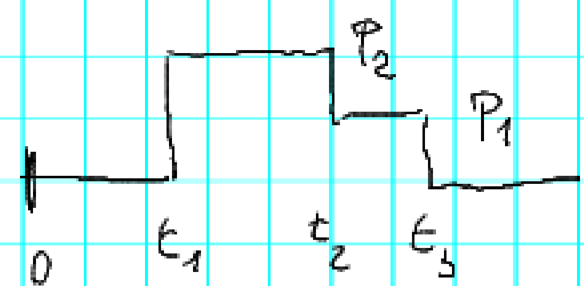
2) FAR more difficult

   turn the above into prescriptions for local shedders

6 Other possibilities for DSC (some examples)

- Load shifting

Nominal power request over time for a certain load



(start of horizon, e.g. day)

1) move it over time

$t_1 \rightarrow t_1 + \delta$ ← decision variable in a cost minimisation problem

$t_2 \quad t_2$

$t_3 \quad t_3$

- load re-distributing

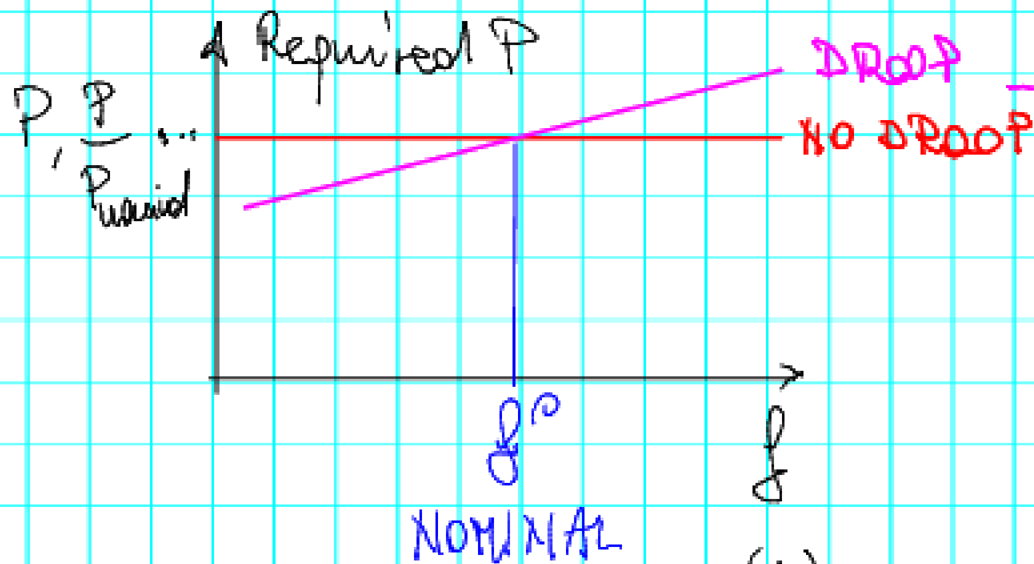
$$\int_{t_1}^{t_2} P_{load\,N}(t - t_1)\,dt \geq E_{min} \Rightarrow \text{CONSTRAINT}$$

$$\int_{t_1}^{t_2} \left(P_{load\,N}(t - t_1) - P^{scheduled}_{load\,N}(t - t_1)\right)^2 dt \leq \text{max difference}$$

decision variables: t_1, (t_2)

$P_{load}(t)$ profile

- loads with "local droop"



: if f goes DOWN / UP then require LESS / MORE power

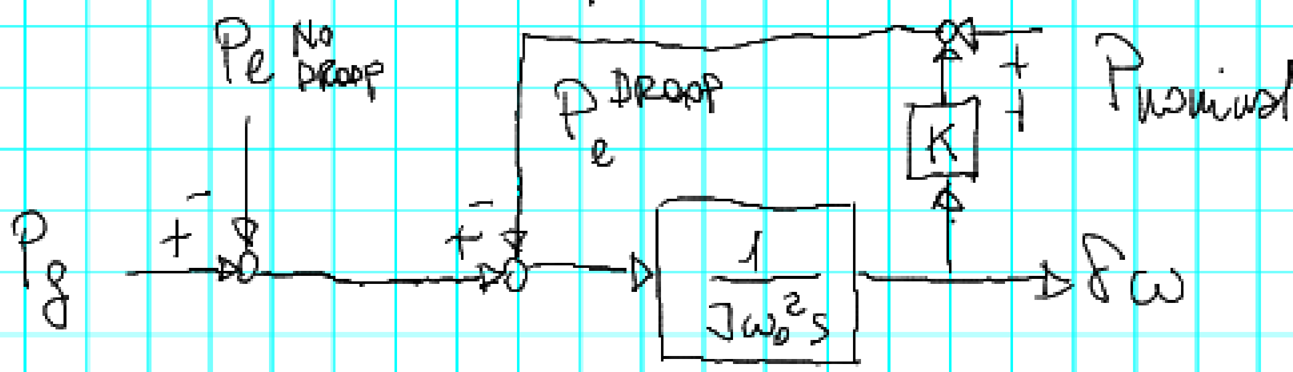
f

ω

$\delta\omega$

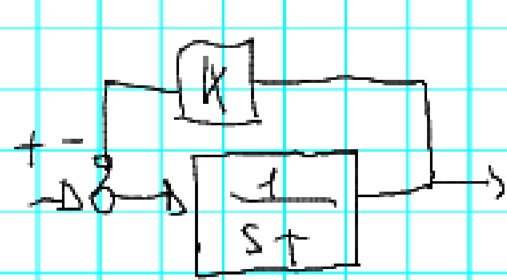
...

9 From the P/f control viewpoint



$$P_{\text{required}} = P_{\text{nominal}} + K_{\text{droop}} \underbrace{(f - f_{\text{nominal}})}_{\text{this can be seen as } \delta\omega}$$

Remark:

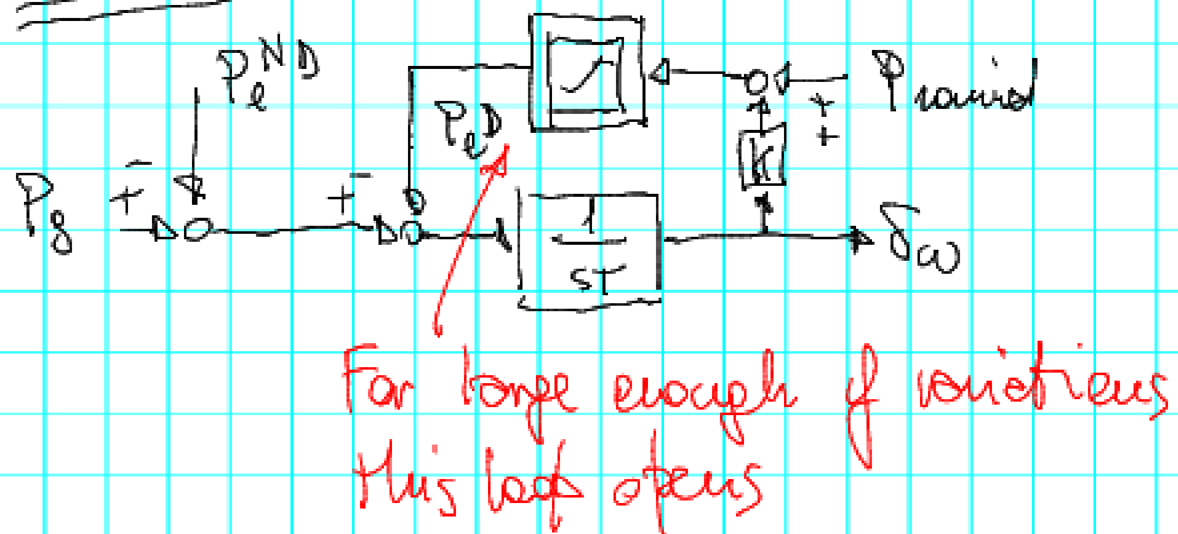


$$\Rightarrow \frac{1/sT}{1+K/sT} = \frac{1}{K+sT}$$

No more integrator!

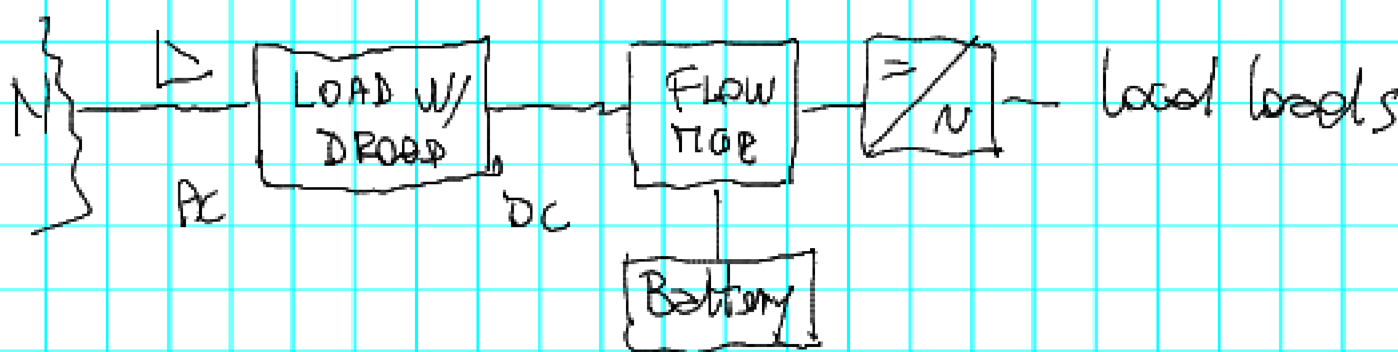
However not all the loads can have a droop

We could view this as



Also, local droops may require to draw power that the load may not be willing / capable of absorbing ⇒ storage

One possibility:



□