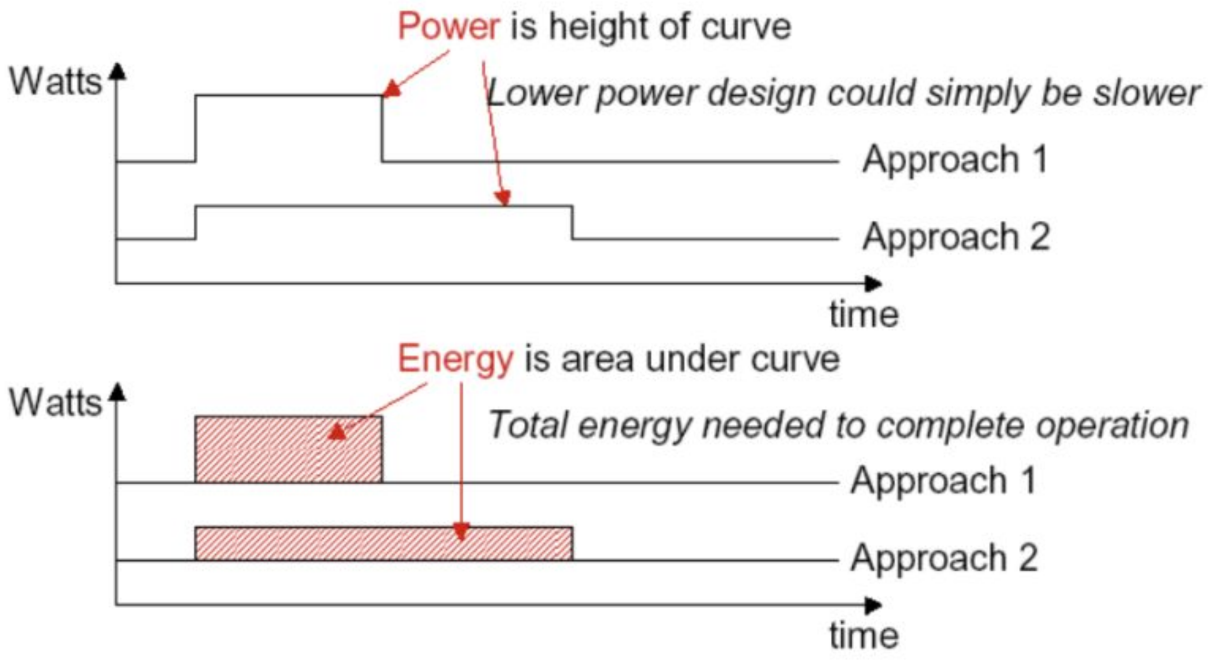
Power

Discussion 9

Announcements

- Final next Thursday (4/26)
  - Some people will be in Moffitt 106, will post final room assignments on Ed
- Homework 5 due 4/23
  - No extensions past 4/23
- Final presentations 9AM-12PM 5/2 (probably in BWRC)

Power vs. Energy



Power dissipation sources

$$P \sim \alpha \cdot (C_L + C_{CS}) \cdot V_{swing} \cdot V_{DD} \cdot f + (I_{DC} + I_{Leak}) \cdot V_{DD}$$

Dynamic power

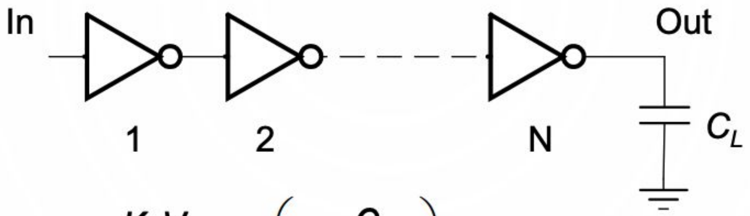
Static power

- α – switching activity
- C_L – load capacitance
- C_{CS} – short-circuit "capacitance"
- V_{swing} – voltage swing
- f – frequency

- I_{DC} – static current
- I_{leak} – leakage current

Alpha-power delay scaling

- Since dynamic power is ~CV_{DD}^2f, we can scale V_{DD} down to reduce power
- This also increases our delay, which reduces our frequency

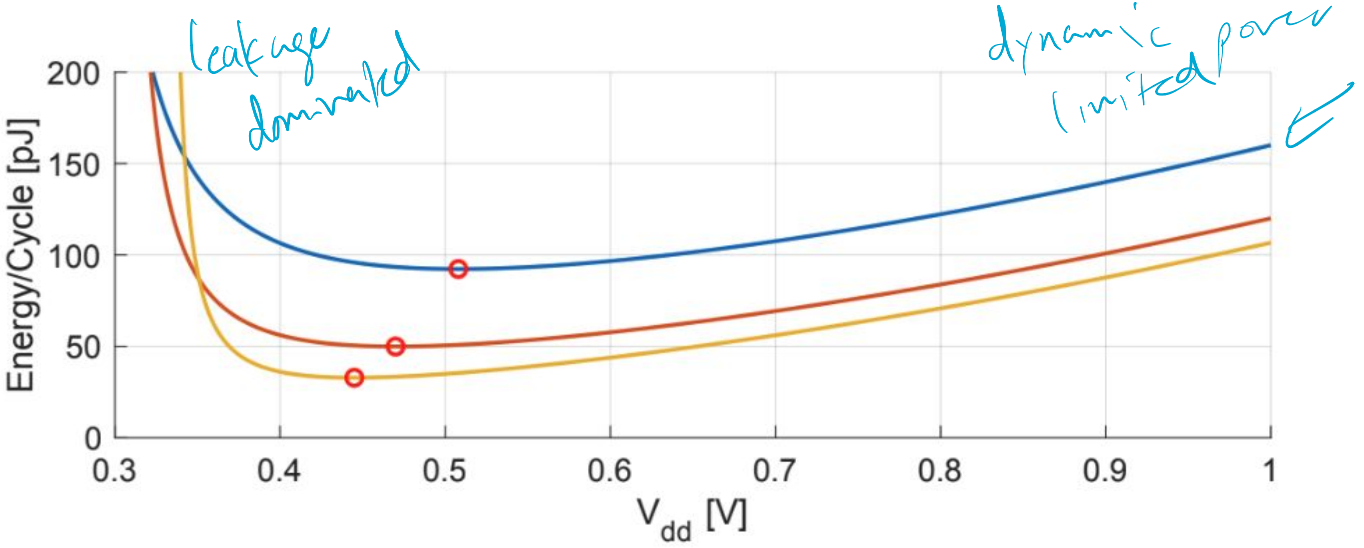


$$t_{pi} = \frac{K_d V_{DD}}{(V_{DD} - V_{Th})^{\alpha}} \left(1 + \frac{C_{L,i}}{C_{in,i}}\right)$$

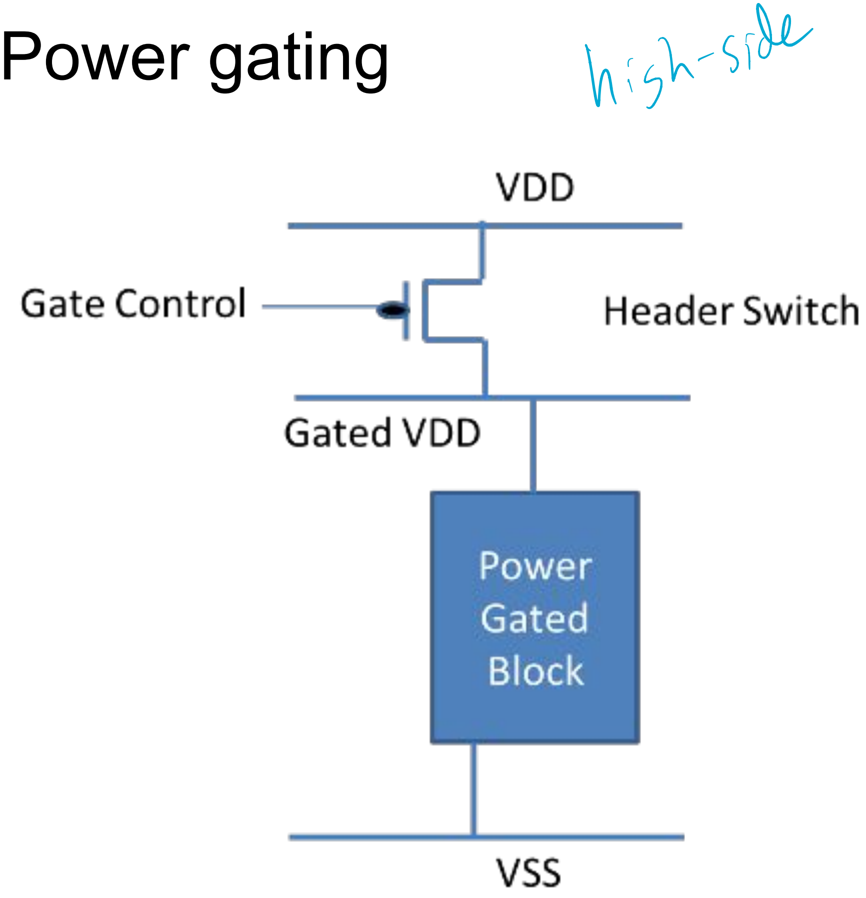
$$D = \sum t_{pi} = \sum \frac{K_d V_{DD}}{(V_{DD} - V_{Th})^{\alpha}} \left(1 + \frac{W_{L,i}}{W_{in,i}}\right)$$

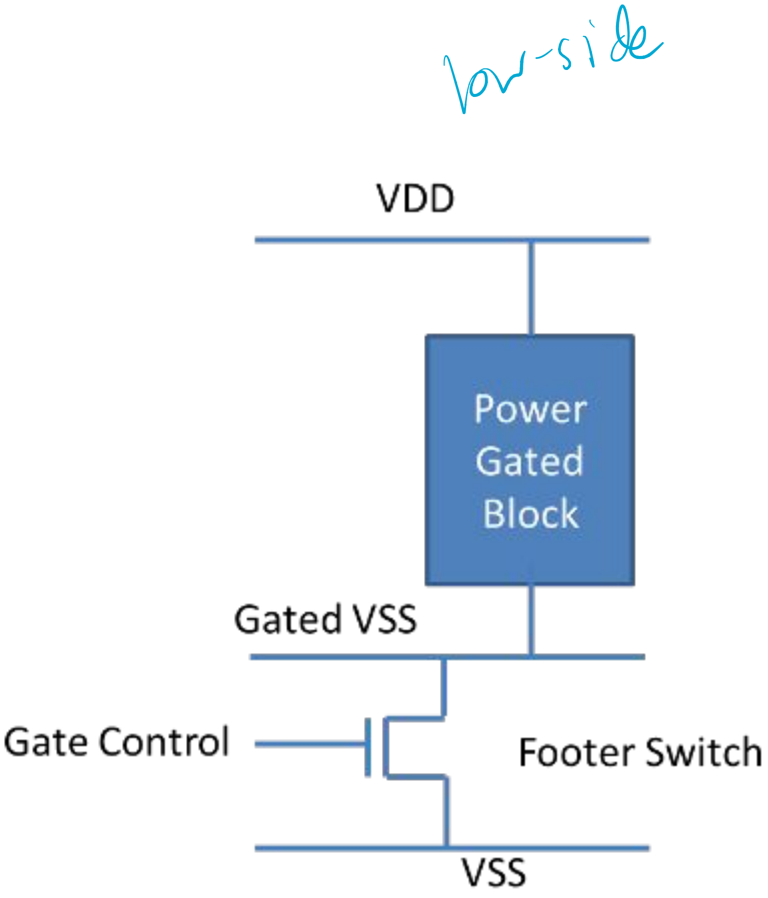
Dynamic voltage-frequency scaling

- Though dynamic power goes down, energy per cycle goes up because leakage power remains relatively constant and cycles are longer



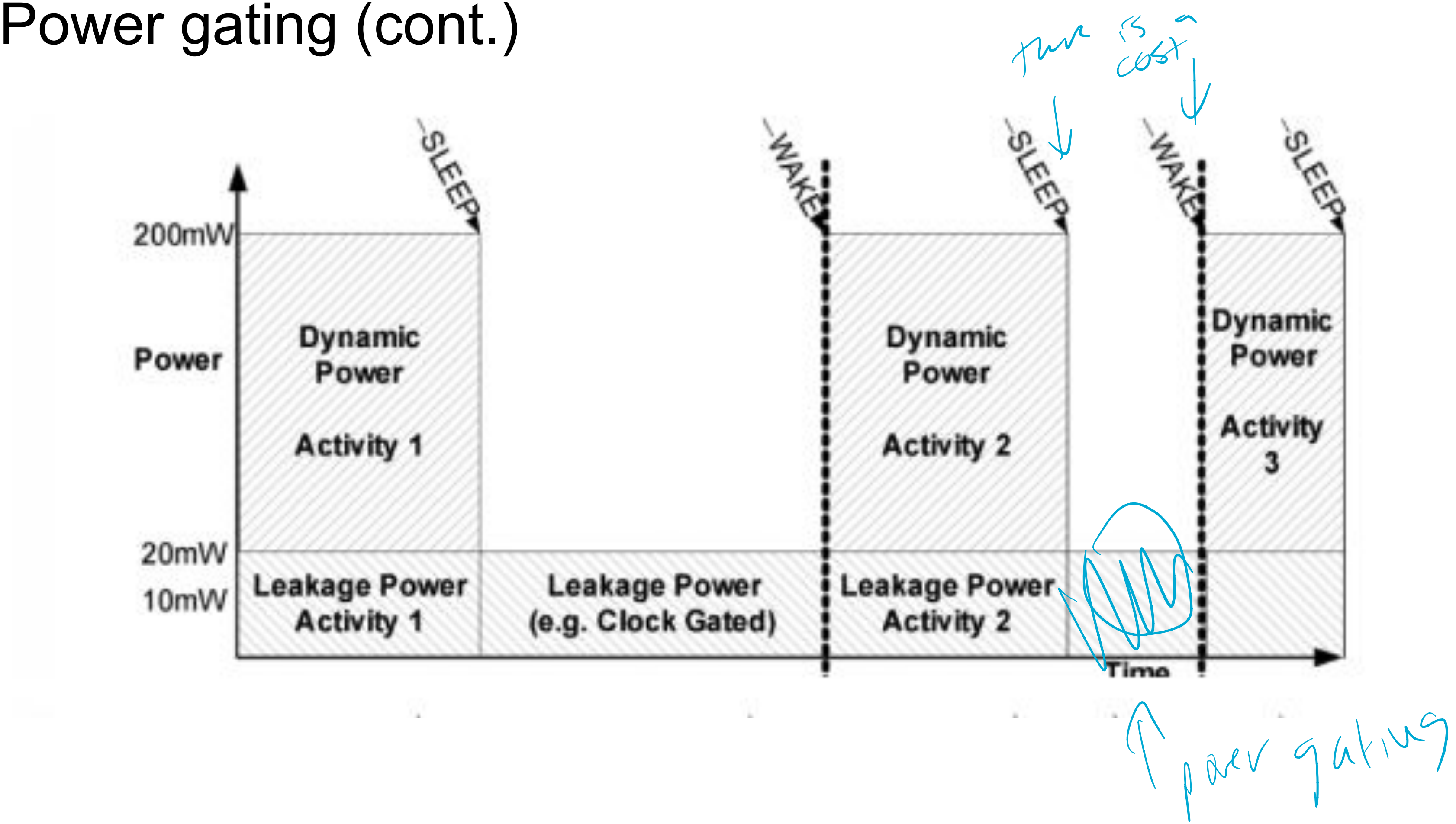
Power gating





https://88physicaldesign.blogspot.com/2016/06/power-gating.html

Power gating (cont.)



Hints for homework

- Maximum voltage droop is given by resistance of power gate times peak current ($I_{pk}R_{pg}$)
- Energy pulled from the supply to switch the power gate is energy required to charge gate to VDD ($C_gV_{DD}^2$)
- When turning off power gate, block + power gate + rail discharges energy
- Power gating can become inefficient if the energy needed to switch the power gate outweighs the leakage energy avoided