EECS150 - Digital Design
Lecture 25 - Power

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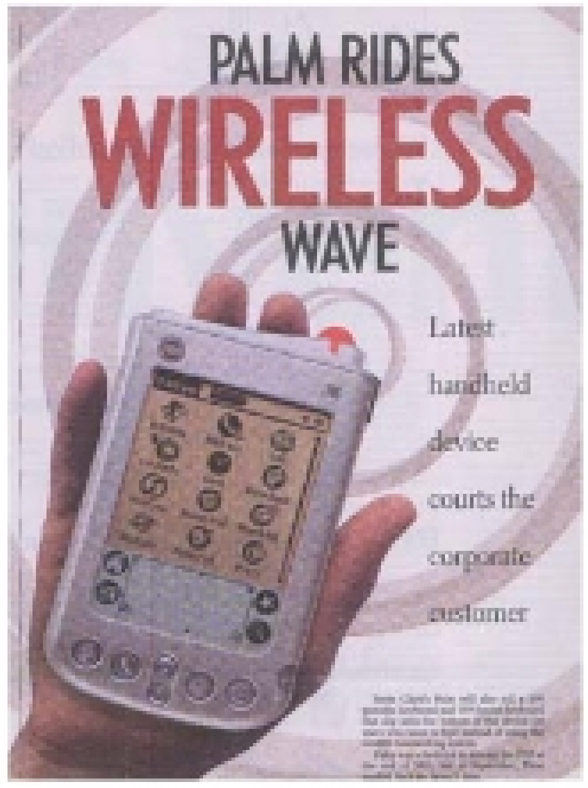
Outline

- Motivation for design constraints of power consumption
- Power metrics
- Power consumption analysis in CMOS
- How can a logic designer control power?

Is Power Consumption Important?



"The internet and wireless services are getting married", Simon Segars

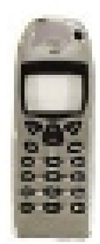
Motivation

Why should a digital designer care about power consumption?

- Portable devices:
  - handhelds, laptops, phones, MP3 players, cameras, … all need to run for extended periods on small batteries without recharging
  - Devices that need regular recharging or large heavy batteries will lose out to those that don't.
- Power consumption important even in "tethered" devices.
  - System cost tracks power consumption:
    - power supplies, distribution, heat removal
  - power conservation, environmental concerns
- *In a span of 10 years we have gone from designing without concern for power consumption to (in many cases) designing with power consumption as the primary design constraint!*

Battery Technology

- Battery technology has moved very slowly
  - Moore's law does not seem to apply
- Li-Ion and NiMh still the dominate technologies
- Batteries still contribute significant to the weight of mobile devices



Nokia 61xx - 33%

Handspring PDA - 10%

Toshiba Portege 3110 laptop - 20%

Basics

- Power supply provides energy for charging and discharging wires and transistor gates. The energy supplied is stored and dissipated as heat.

$$\boxed{P \equiv dw/dt}$$

Power: Rate of work being done w.r.t time.
Rate of energy being used.

Units: $P = E/\Delta t$ *Watts = Joules/seconds*

- If a differential amount of charge dq is given a differential increase in energy dw, the potential of the charge is increased by: $V = dw/dq$
- By definition of current: $I = dq/dt$

$$dw/dt = \frac{dw}{dq} \times \frac{dq}{dt} = \boxed{P = V \times I}$$

A very practical formulation!

$$w = \int_{-\infty}^{t} P\,dt \quad \textit{total energy}$$

If we would like to know total energy