Notes for 12/4/09

How and why does performance scale with system size?

Organisms: single cell to trillions of cells
Social insect colonies: 10's to millions of ants
Microprocessor: 1000's to billions of transistors
Computer networks: tens to billions of hosts

Network capacity limits performance as systems scale
Made manifest in terms of metabolism, response times, and power consumption

Moore's law: transistor count doubles every 24 months
Moore's law was initially an empirical observation
But why is it true?

Transistor number increases primarily by increasing density, secondarily by increasing area

Power scaling:
1970: 100 watts powers 15 MIPS
2005: 100 watts powers 6700 MIPS
But wire scaling prevents better returns: as you increase transistors, the number of wires to connect them increases faster
We have power law scaling

Rent's rule: A scaling relation between the number of I/O pins and the number of components on an integrated circuit; can be used to predict wire scaling
Rent's rule is another empirical observation

Try to apply network scaling from biology
Mass vs. metabolic rate: another power law... the more massive, the lower the metabolic rate
Our “wire scaling” here is circulatory scaling

Clock trees scale like circulatory networks
Both are space filling, fractal branching