Embedding the Internet

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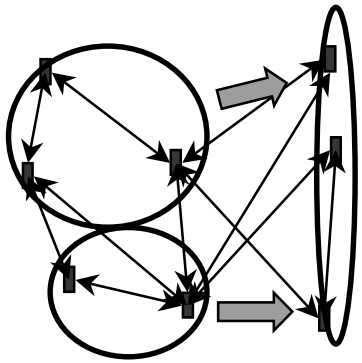
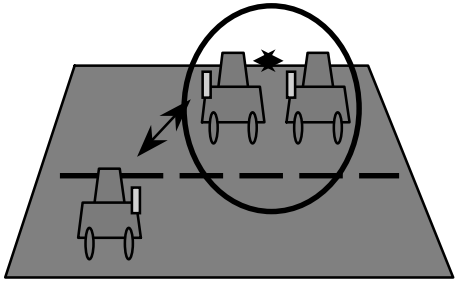
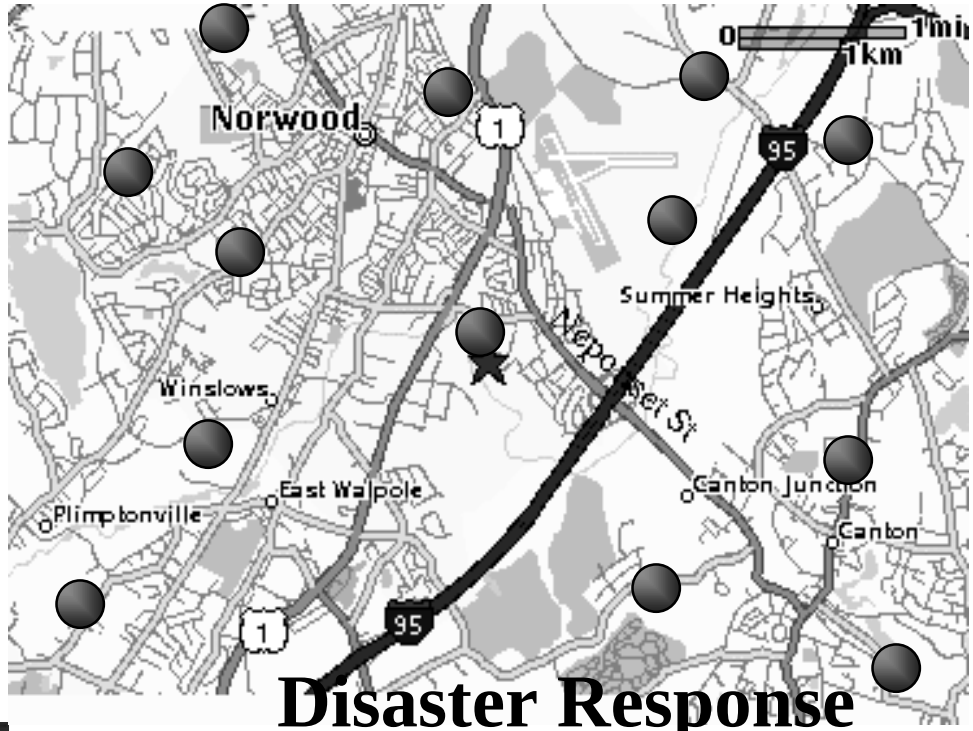
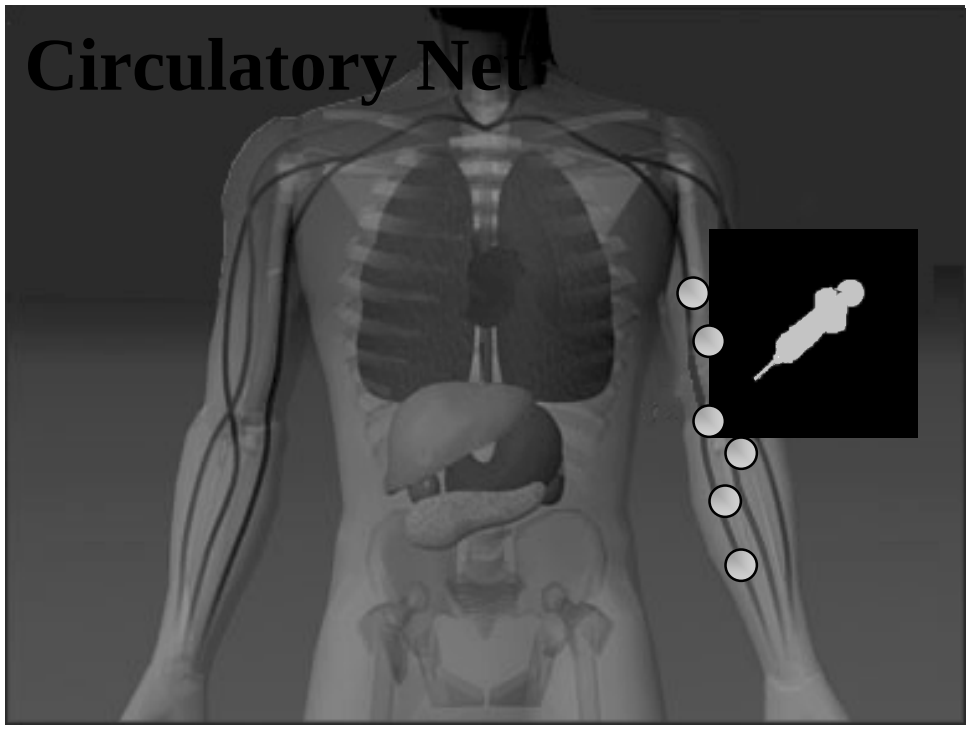




Embed numerous distributed devices to monitor and interact with physical world: in factories, hospitals, offices, homes, vehicles, and the human body



Disaster Response



Leverage off pervasive physical locality between nodes and subject

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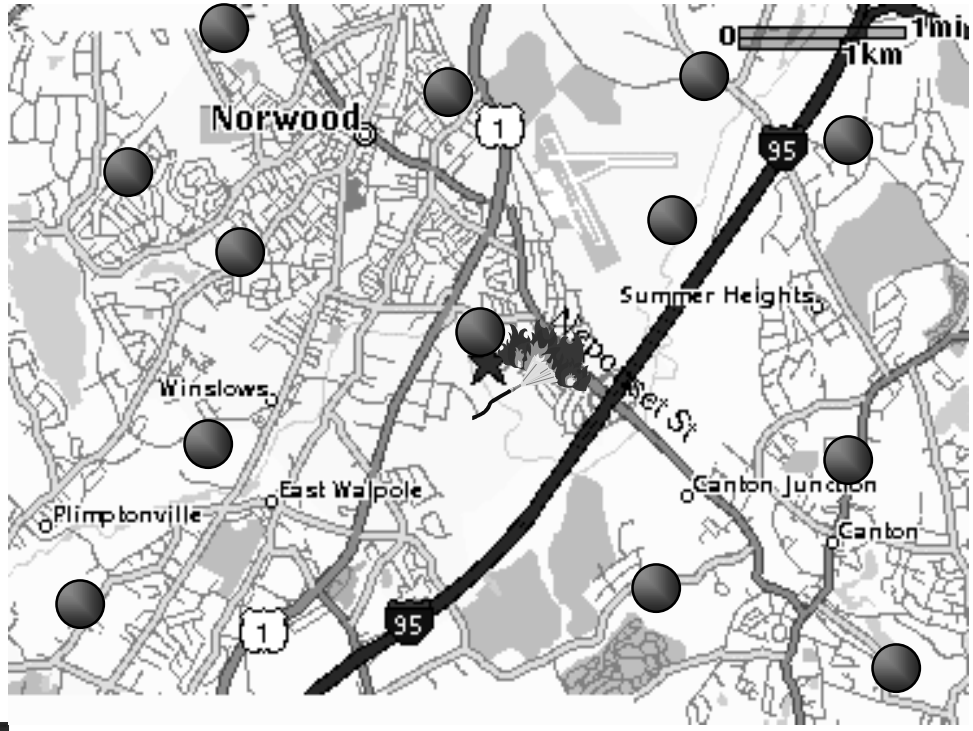

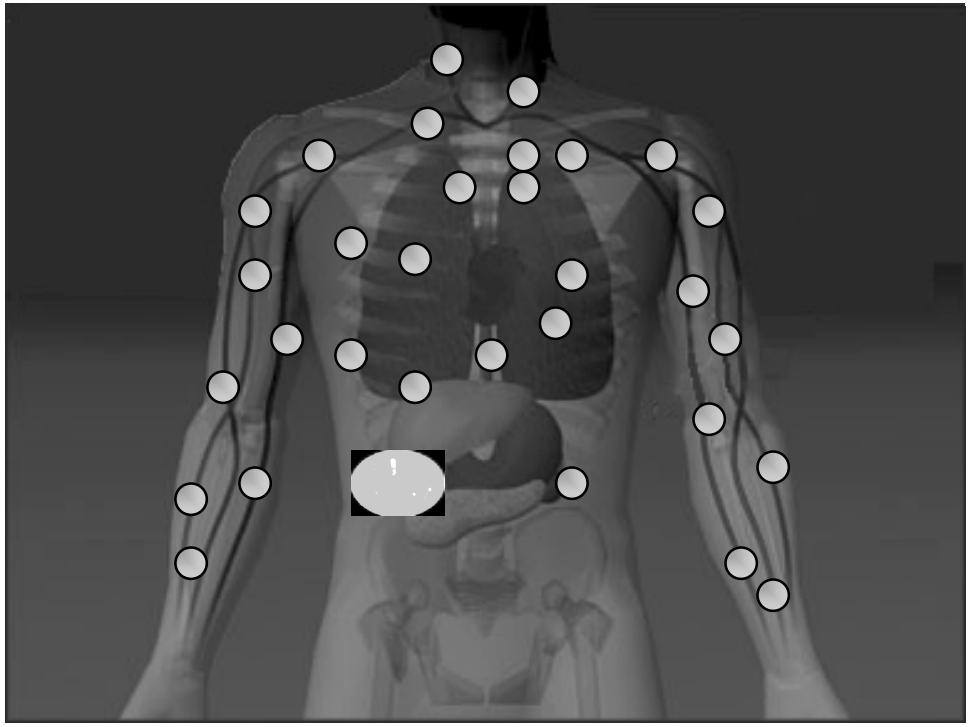

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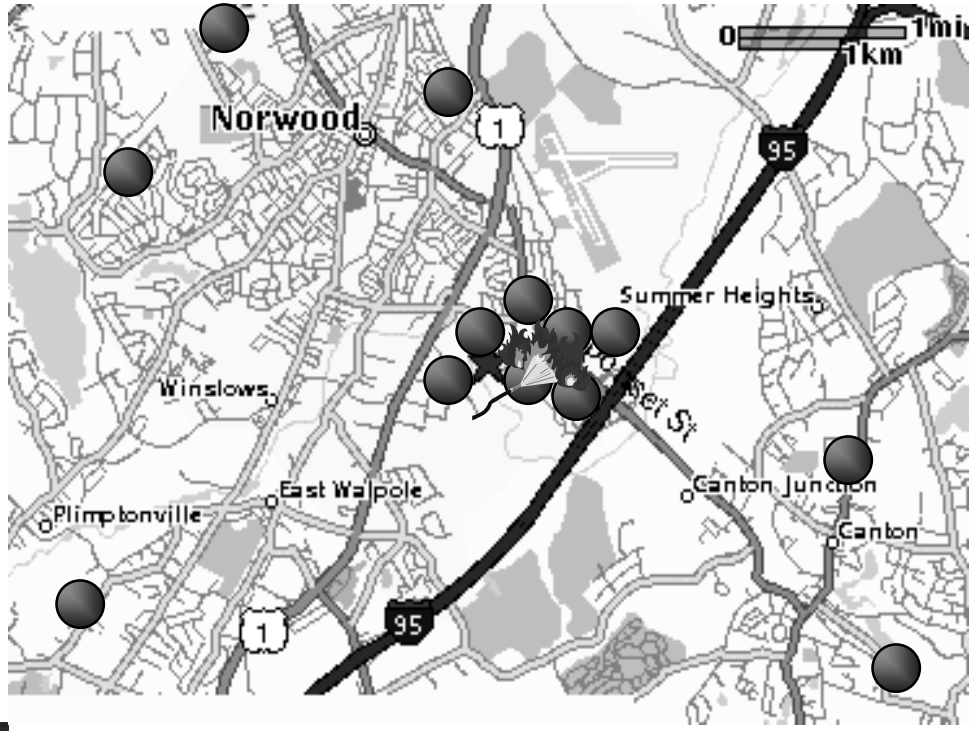

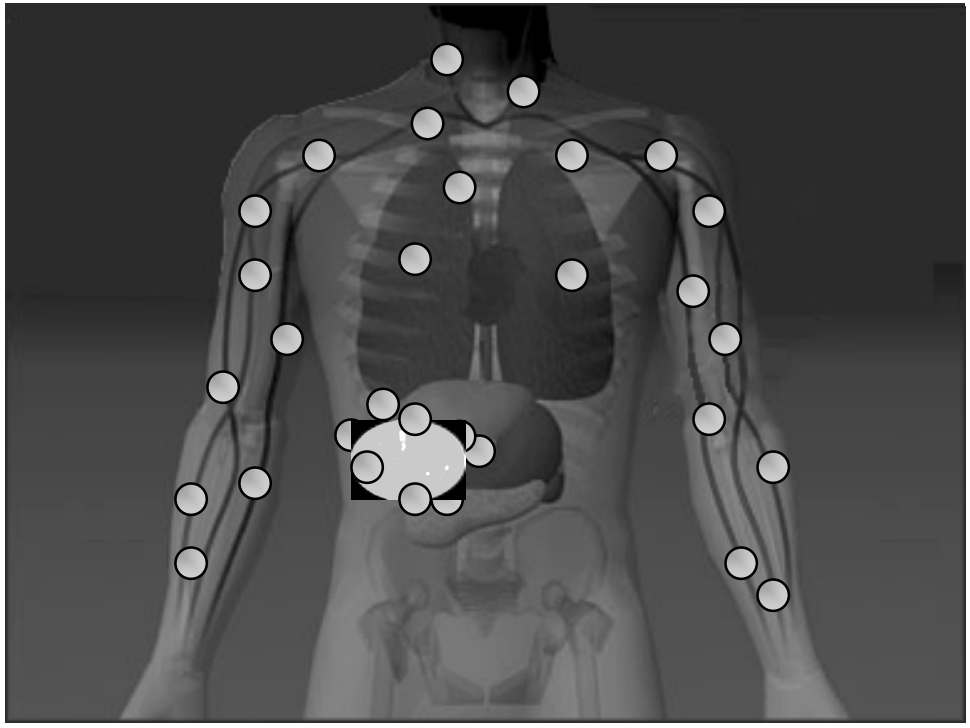

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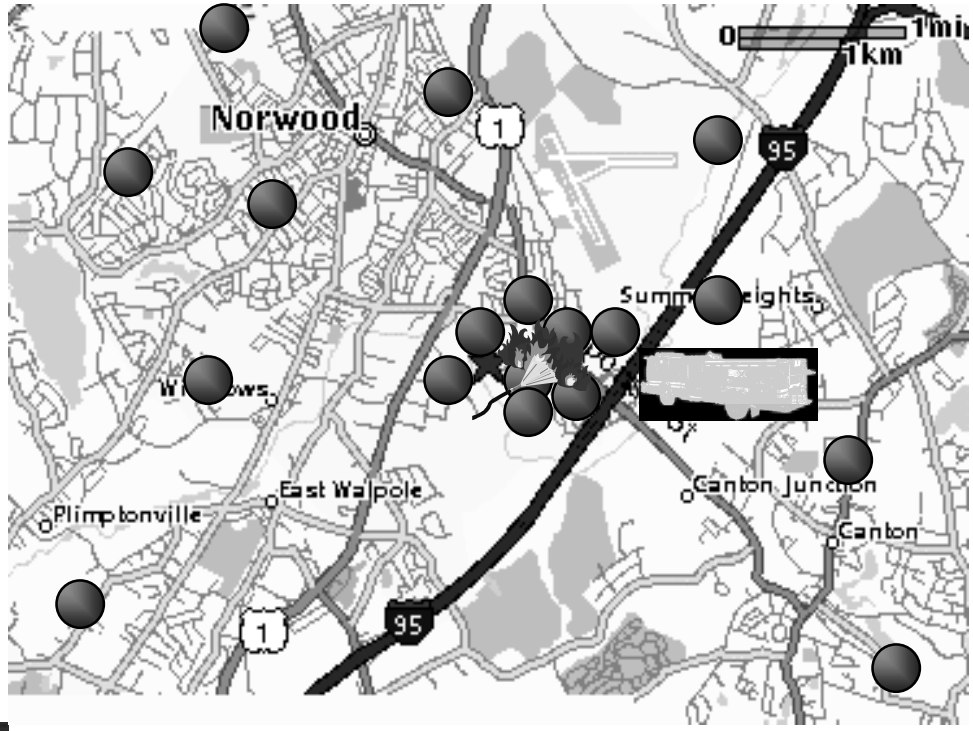

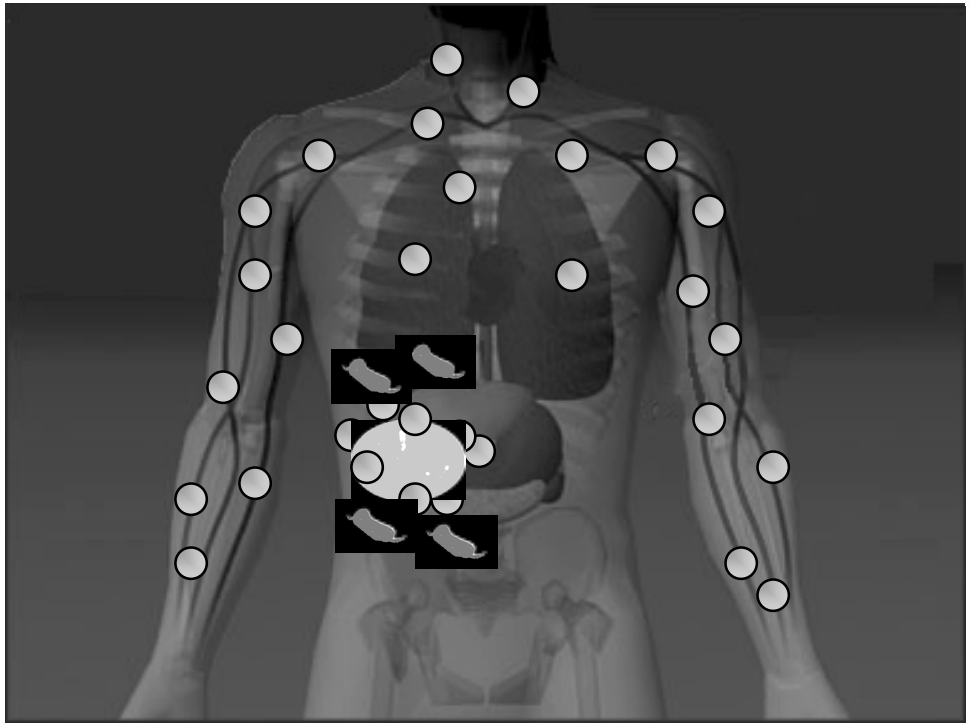

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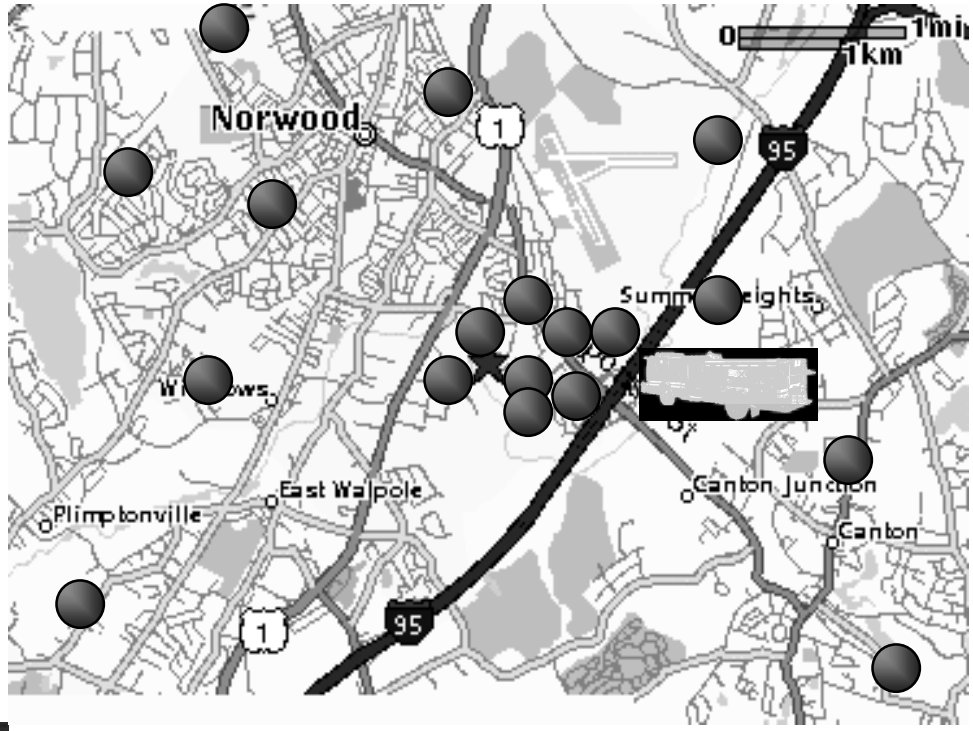

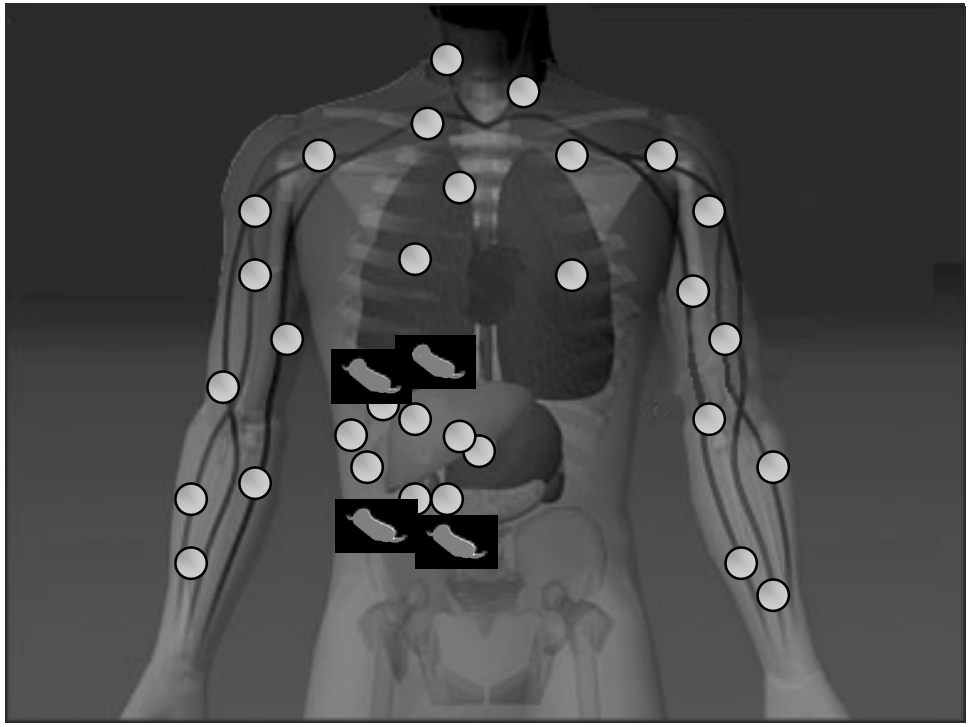

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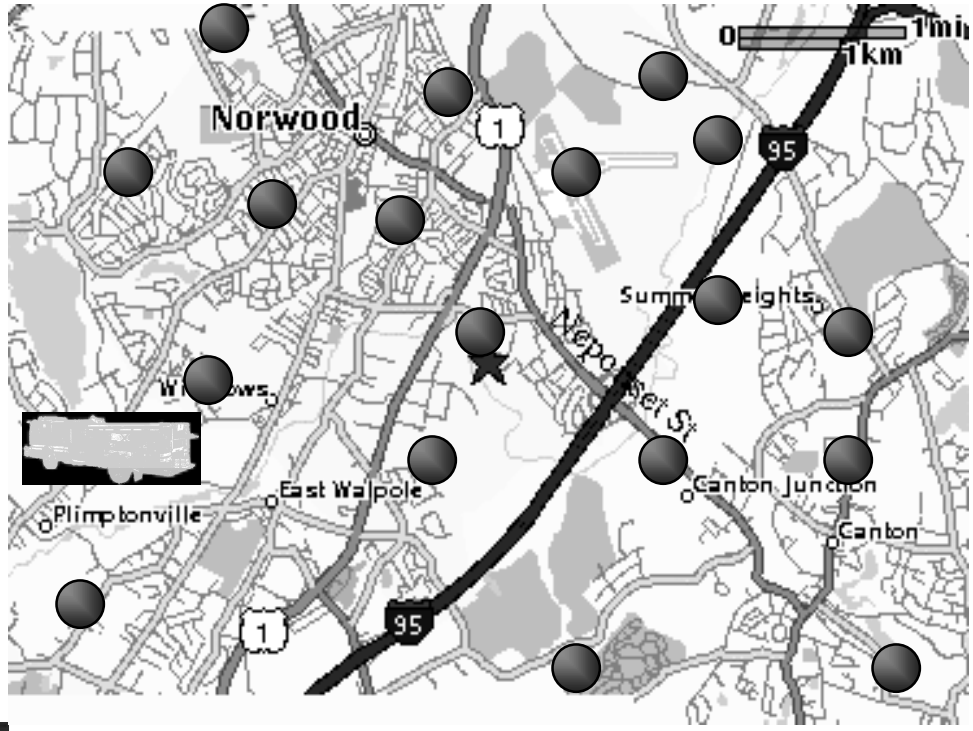
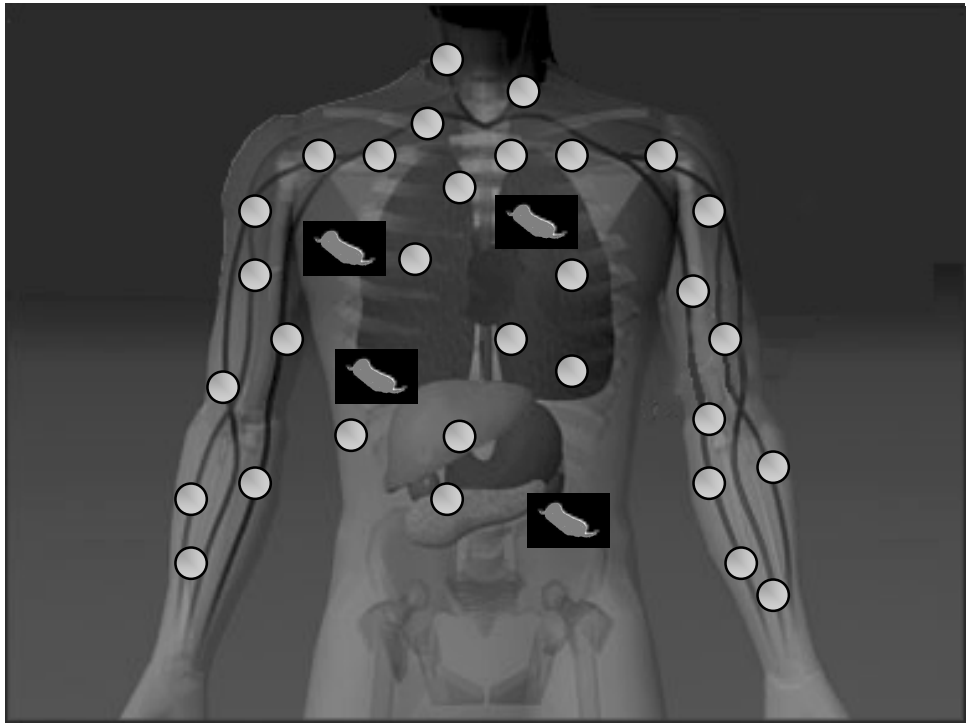
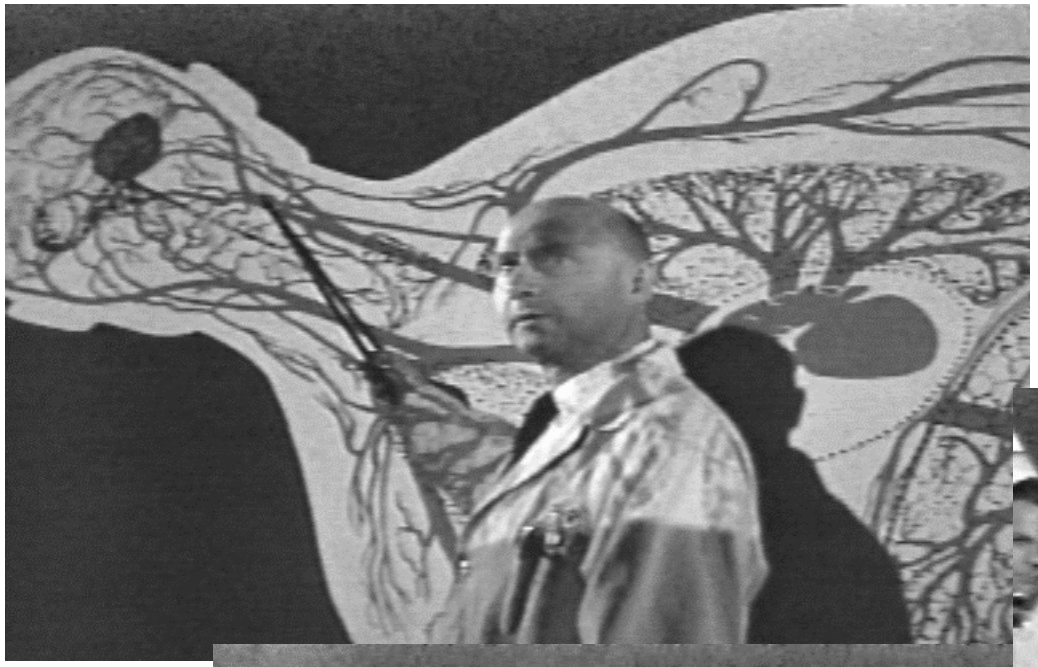
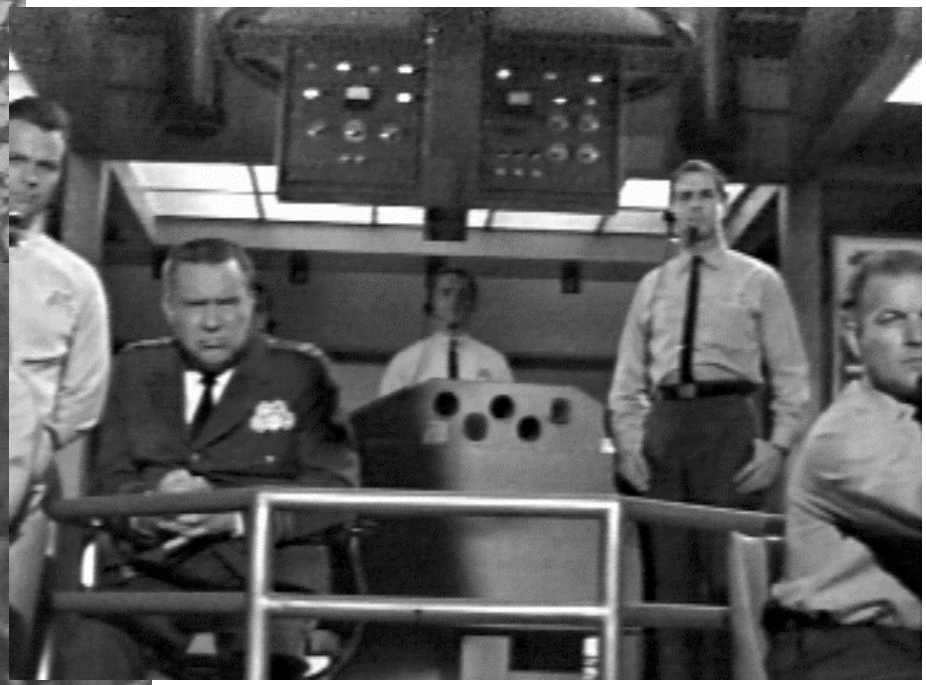




Leverage off pervasive physical locality between nodes and subject

Circulatory Net: not a new vision...





New Vision

- Embed large numbers of small, low-power, computationally powerful, communicating devices...
- Communicate to correlate and coordinate
- Design, deploy, and control ***robust*** distributed systems composed of tens of thousands of physically-embedded devices

The Challenge is Dynamics

- The physical world is dynamic
  - Dynamic operating conditions
  - Dynamic availability of resources--***particularly energy!***
  - Dynamic tasks
- Devices must adapt automatically to the environment
  - Too many devices for manual configuration
  - Environment is not under our control
- **Research challenge**

  Coordination and control algorithms for large scale, highly dynamic, unattended, distributed systems

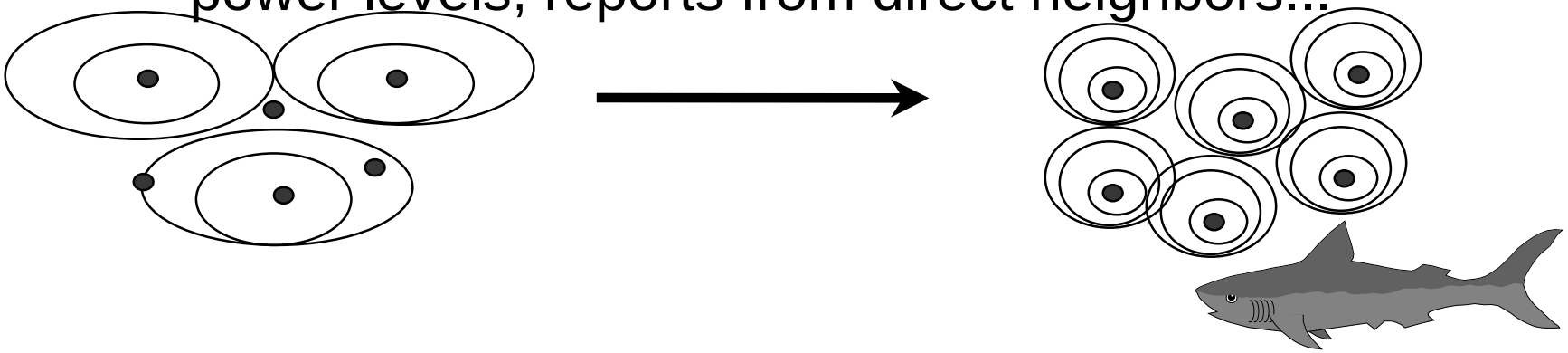
Borrowing Ideas from the Internet

- Achieve desired global behavior through ***localized interactions***
  - Design for robust operation and incremental deployment

- ***Empirically adapt*** to observed environment--a priori assumptions are only hints
  - Design for continual change

Adaptive Fidelity: combining localized behavior and empirical adaptation

- Example: to get a better picture turn on more sensors
  - Nodes adjust their coverage, sampling rate, communication frequency based on neighbor density, power levels, reports from direct neighbors...



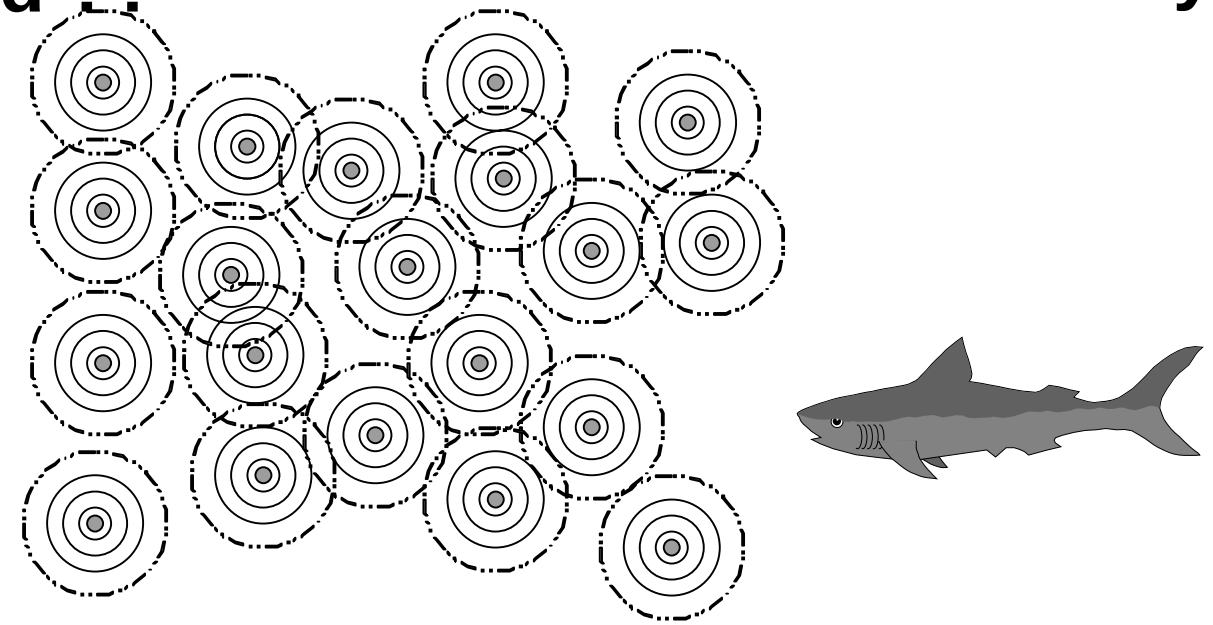
  - Automate analysis of ways to improve fidelity: self-configure to mobilize more nodes when needed, or turn-off nodes when not needed to extend lifetime

Challenge for Global System Characterization

Given a system composed of nodes running locally adaptive algorithms, how do we characterize and quantify global behavior??

sources required ??

data accuracy ??



responsiveness ??

cascading failure modes ??

Enormous Potential Impact