CS428: Information Processing for Sensor Networks

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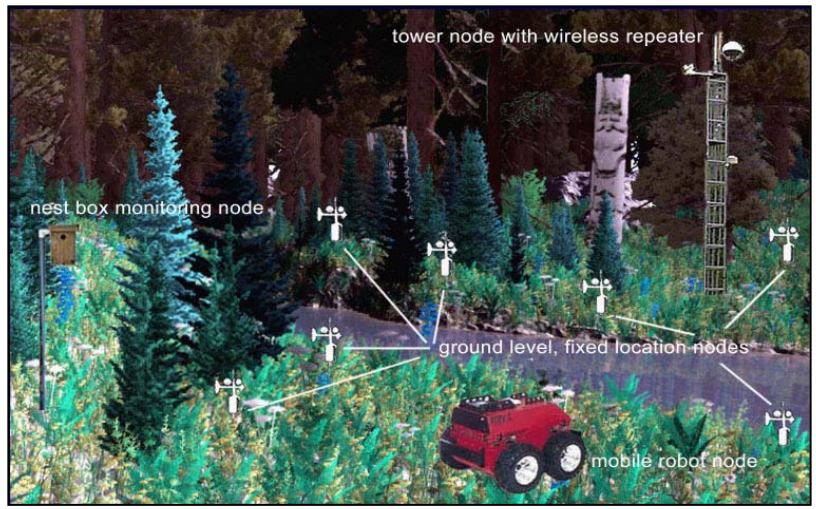


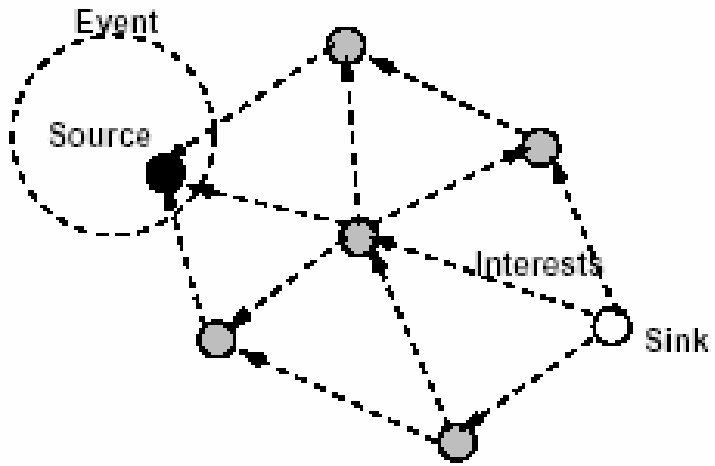
Key Research Challenges at the Node and System Levels

The setting:

- power conservation is important:
  - untethered node operation
  - communication far more expensive than computation (sensing, too)
- *ad hoc* deployment in noisy, adverse environments
  - self-initialization, self-configuration
  - robustness to individual node failure

“Semantic” Routing and Networking

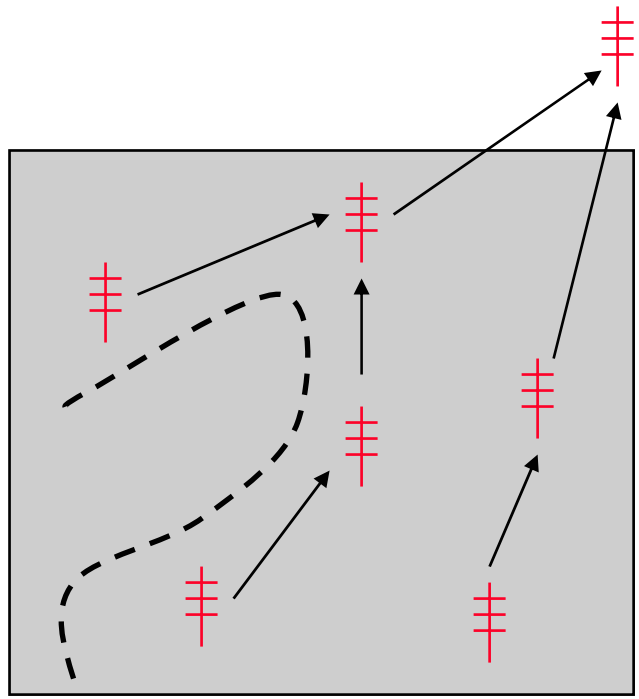
- We want to address spatial locations or information, not individual nodes
- “Content” and “address” in a message get intermixed
- How do we help information providers and clients find each other?



Directed diffusion
Geo-routing

In-Network Processing

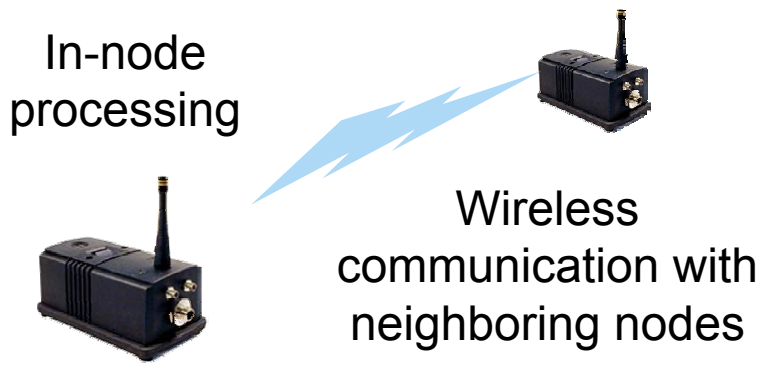
- Information aggregation on the way to the destination
- Need to balance quality of paths with quality of information collected
- Are there “application-independent” paradigms of information aggregation?



Temperature aggregation

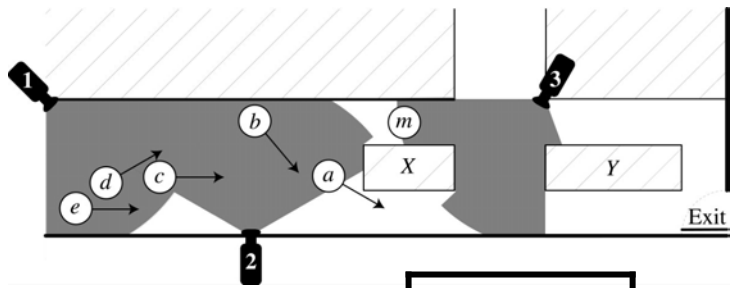
Power-Aware Sensing and Communication

- Variable power systems
- Let most sensors sleep most of the time; paging channels
- Exploit correlation in readings between nearby sensors
- Load-balance, to avoid depleting critical nodes



Sensor Tasking and Control

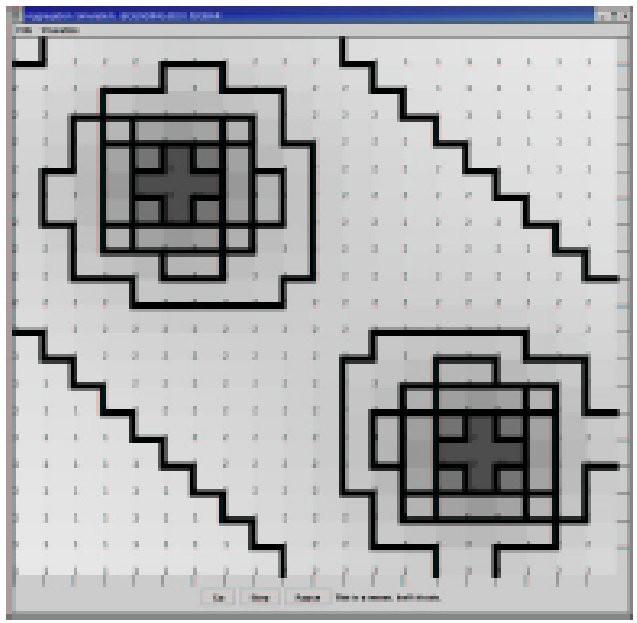
- Decide which sensors should sense and communicate, according to the high-level task – a non-trivial algorithmic problem
- Direct sensing of relations relevant to the task – do not estimate full world state



a ahead-of *b*
b ahead-of *c*
c ahead-of *d*
d ahead-of *e*

Enable Data-Base Like Operations

- Data only available right after sensing operation
- Dense data streams must be sampled, or otherwise summarized
- Must deal with distributed information storage – “where is the data?”

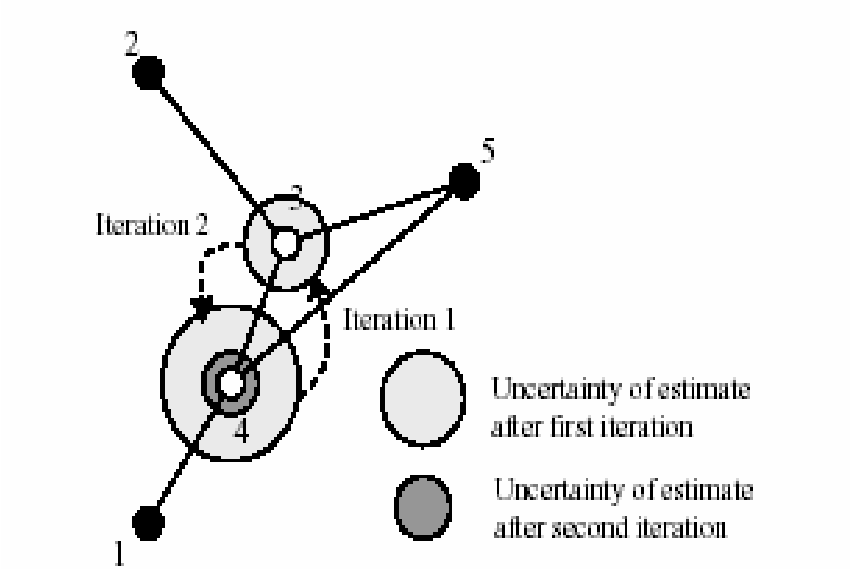


(a) Lossless Isobars

Field isolines

Self-Configuration for Ad-Hoc Deployment

- Network size makes it impossible to configure each node individually
- Environmental changes may require frequent re-calibration
- Network must recover after node failures

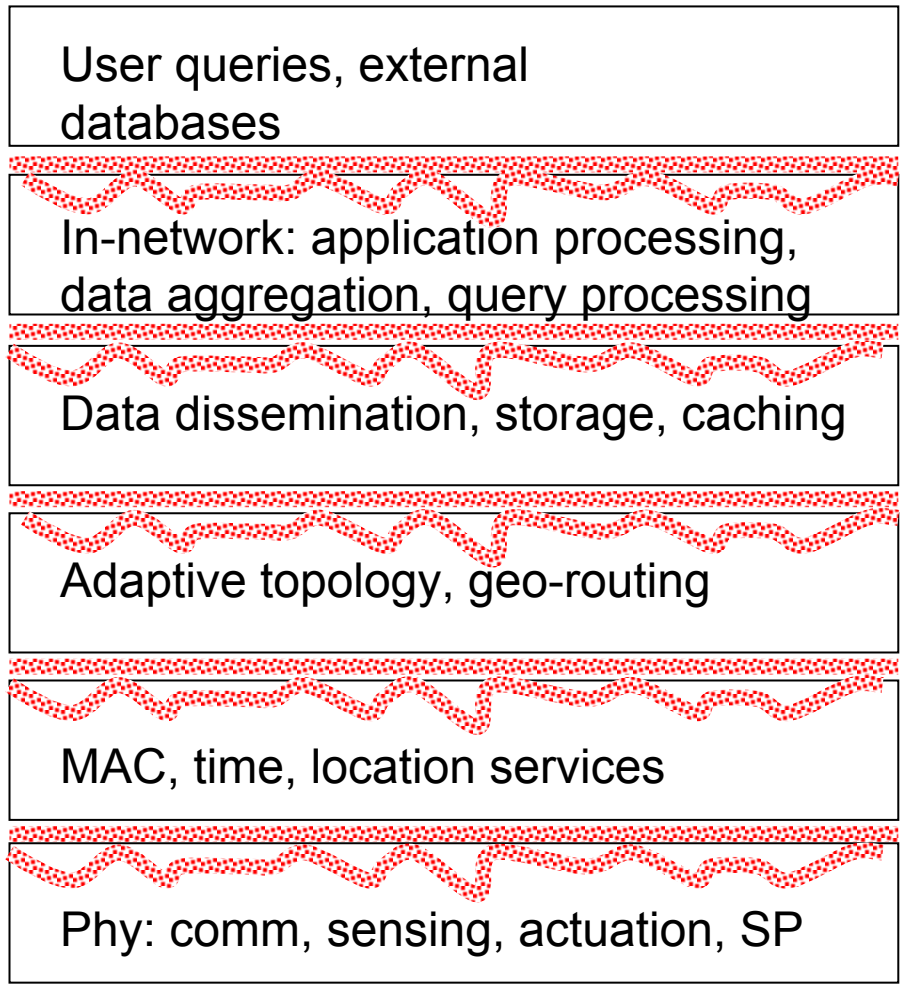


Iterative localization

New System Architectures

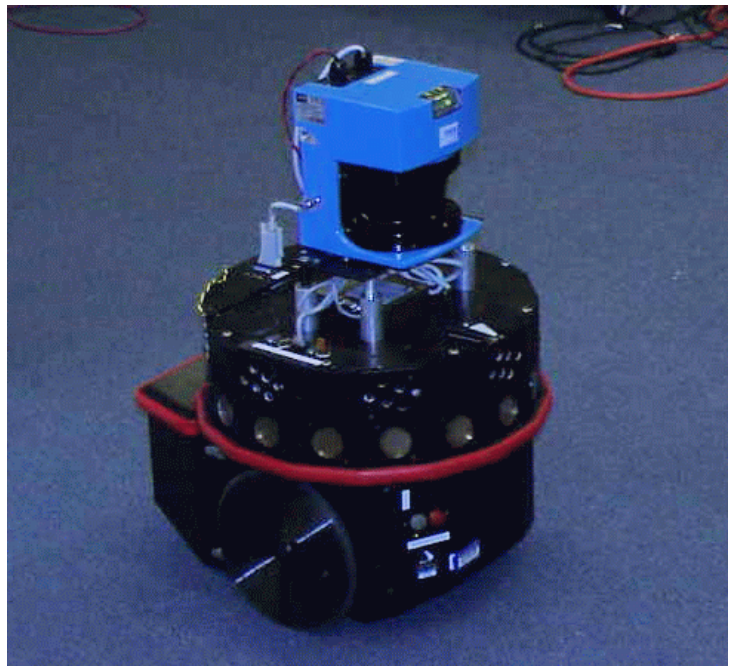
- Resource constraints require close coupling between the layers
- Can we define *application-independent* programming abstractions for sensor nets?

A sensor net stack?



Various Issues

- Integration of sensors with widely different modalities
  - High data-rate sensors (cameras, laser scanners)
- Sensor mobility
- Actuation



Distributed robotics

Conclusion

- Ubiquitous networked sensors provide a dense spatial and temporal sensing of the physical world
- They potentially provide low-latency access to information that is highly localized in time and space, and thus provide a way to sense and act on the physical world beyond what has been possible up to now
- Sensor networks raise many research issues at the physical node level, the system architecture level, and the algorithm deployment level