Sensor Network Information Flow Dynamics

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- Optimum information flow in wireless sensor networks become computationally prohibitive when the number of nodes grows large.
- Instead of modeling the network as a discrete nodes, the wireless sensor network can be modeled as a continuum of nodes covering an area (namely A) in R^2 plane.
- In a dense wireless network, information can be treated like a fluid. **Information flow vector field, *D*,** satisfies the following equations:

$$\nabla \cdot D = \rho(z) \quad z \in A$$

$$D \cdot n = 0 \qquad z \in \partial A$$

$$D^* = \arg\min \int_A \| D(x,y) \|^2 \, dxdy$$

$$\Rightarrow \nabla \times D^* = 0 \Rightarrow D^* = \nabla u$$

- Potential function *u* satisfies Poisson's equation:

$$\nabla^2 u = \rho(z) \quad z \in A$$

$$\frac{\partial u}{\partial n} = 0 \qquad z \in \partial A$$

- Using Gauss Harmonic Theorem a distributed solution of this PDE on a stochastic grid is calculated using:

$$\hat{u}(z) = \frac{1}{M} \sum_{i=0}^{M-1} u(z_i) - \frac{E[r^2]}{4} \rho(z)$$