

# Voronoi Scoping in Sensor Networks

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## Introduction: Data Gathering with Multiple Basestations

### Using a Single Sink (Basestation)

- **Overview**
  - Sink floods *interest messages* into the network.
  - Interest floods serve to *construct tree topology* (reverse-path of flood) and to *task nodes* (what/when to sense/report).
- **Drawbacks:**
  - Unique point of failure.
  - Uneven load balancing (top-level nodes carry more traffic).
  - Tree depth and path lengths increase with network size, hence delivery rate decreases

### Using Multiple Sinks

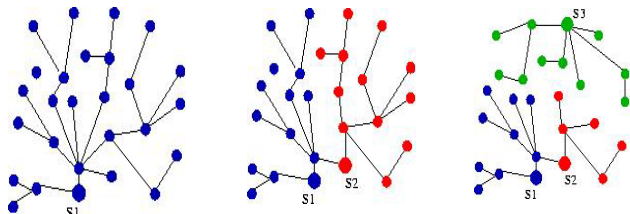
- **Overview**
  - Each sink floods independently; one data-gathering tree per sink.
  - Data from a node need only arrive *at one sink* (assume that basestations are powered; have reliable storage or network connection).
  - Preferably data goes to *the nearest* (in hops) sink.
- **Alleviates problems associated with single sink.**
- **Therefore, we expect that most data-gathering deployments will use multiple basestations.**

## Problem Description: Global flooding from each sink is redundant and costly

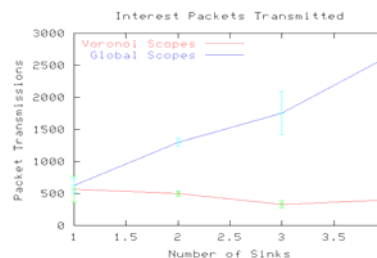
### Can we scope floods from different sinks to reduce flooding overhead?

- **Desired Properties:**
  - Different sinks flood different portions of network.
  - Restrict the overlap between floods from different sinks.
  - Decrease flooding overhead.
- **Requirements:**
  - Each node receives the floods from its “nearest” sink (in topology).
  - Uneven load balancing (top-level nodes carry more traffic).
  - Tree depth and path lengths increase with network size, hence delivery rate decreases.
- **TTL Scoping will not work!**
  - How to set the appropriate TTL at each sink?
  - If TTL to be too small then some nodes will starve, if too large then needless overlap.
  - Tree depth and path lengths increase with network size, hence delivery rate decreases.
  - Requires some form of sink coordination.
  - Isotropic: won't help if two sinks fairly close to each other.

## Proposed Solution: Each node only rebroadcasts flood packets coming from closest sink.



Same network topology with (l. to r) 1, 2, and 3 sinks.



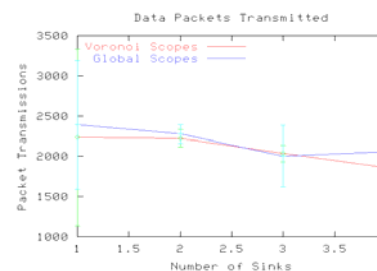
Flooding overhead increases linearly with global flooding; remains constant with voronoi scoping.

### Voronoi Scoping Rule

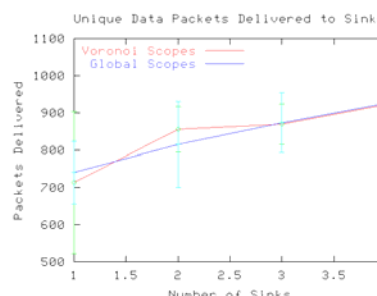
- **A node only re forwards a flood packet if the packet came from the closest sink (that this node knows about).**
- **Properties:**
  - Scoping decision entirely distributed (unlike TTL scoping).
  - If sink comes up or sink dies: scopes adaptively grow/shrink, other sinks do not need to keep track.
  - Decrease flooding overhead.
  - Can retain some overlap between clusters by trivial modification to above rule.
  - Fits in with classical distributed flooding/tree-construction mechanisms.
  - *Flooding overhead remains constant independently of # of sinks!*

### Experiment notes

- Used LECS ceiling array, 55 Berkeley motes.
- Protocol implemented as modification of One-Phase Pull Diffusion (Heidemann et al).
- Used existing diffusion implementation from ISI (F. Silva)
- 1, 2, 3, 4 sinks.
- Each sink floods every 120 seconds.
- Each node generates data packet every 60 seconds.



Data packet transmissions are identical for both protocols.



For both protocols, packet delivery rate increases with number of sinks.