TTDD: A Two-tier Data Dissemination Model for Large-scale Wireless Sensor Networks

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Outline

- Data dissemination to mobile sinks
- Two-tier query and data forwarding
- Performance evaluation
- Related work
- Conclusion
Sensor Network Model
Mobile Sink

- Excessive Power Consumption
- Increased Wireless Transmission Collisions
- State Maintenance Overhead
Challenges

- Battery powered sensor nodes
- Communication via wireless links
  - Bandwidth constraint
  - Load balancing
- Ad-hoc deployment in large scale
  - Fully distributed w/o global knowledge
  - Large numbers of sources and sinks
- Unexpected sensor node failures
- Sink mobility
  - No a-priori knowledge of sink movement
Goal, Idea

- Efficient and scalable data dissemination from multiple sources to multiple, mobile sinks
- Two-tier forwarding model
  - Source proactively builds a grid structure
  - Localize impact of sink mobility on data forwarding
  - A small set of sensor node maintains forwarding state
TTDD Basics

Dissemination Node

Data Announcement

Source

Data

Immediate Dissemination Node

Sink

Query
TTDD Mobile Sinks

Dissemination Node

Data Announcement

Source

Data

Immediate Dissemination Node

Trajectory Forwarding

Sink
TTDD Multiple Mobile Sinks

Dissemination Node

Data Announcement

Source

Data

Source

Immediate Dissemination Node

Trajectory Forwarding
Grid Maintenance

- Issues:
  - Handle unexpected dissemination node failures
  - Efficiency

- Solutions:
  - Source sets the Grid Lifetime in Data Announcement
  - **DN replication**: each DN recruits several sensor nodes from its one-hop neighbor, replicates the location of the upstream DN
  - DN failure detected and replaced **on-demand** by on-going query and data flows
Grid Maintenance

Source

Dissemination Node

Data

Immediate Dissemination Node

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TTDD @ MOBICOM'02
Grid Maintenance (cont’d)

Source

Dissemination Node

Data

Immediate Dissemination Node
Performance Evaluation

- Compare with sink-oriented data dissemination approaches
  - Communication overhead
    \[
    \frac{CO_{TTDD}}{CO_{SODD}} \to \frac{1}{mk} \left( 1 + \frac{4}{\sqrt{n}} \right)
    \]
  - State maintenance complexity
    \[
    \frac{S_{TTDD}}{S_{SODD}} \to \frac{sb}{n(D - 1)}
    \]
Ns-2 Simulation

- Metrics
  - Energy consumption, delay, success rate

- Impacts of
  - Cell size
  - Number of sources and sinks
  - Sink mobility
  - Node failure rates
Related Work

- SPIN (Mobicom 1999)
  - Data dissemination to all sensor nodes
- Directed Diffusion, DRP, GRAB (2000)
  - Flat dissemination structure, stationary sinks
- GAF (Mobicom 2001)
  - Turn off redundant nodes in MANET
  - Pre-defined grid, cell size determined by radio
- Ad hoc network clustering
  - Node mobility causes high infrastructure maintenance overhead
Conclusion

- **TTDD**: two-tier data dissemination Model
  - Exploit sensor nodes being stationary and location-aware
  - Construct & maintain a grid structure with low overhead

- **Proactive sources**
  - Localize sink mobility impact

- **Infrastructure-approach in stationary sensor networks**
  - Efficiency & effectiveness in supporting mobile sinks