Data Gathering in Active RFID Networks Using a Mobile Reader

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Introduction

- **R**adio **F**requency **Id**entification- used for wireless ID information transfer (replaces barcodes)

- Two types:
  - — Passive: no power source, limited memory and small communication range
  - — Active: powered, more computational and storage resources and larger communication range (can communicate with other active tags)
- In a warehouse crates of items are stored and each item has a passive RFID tag (for supply chain management and object tracking)
- Mobile readers (human or robot) are used to gather data about items in a warehouse and answer queries

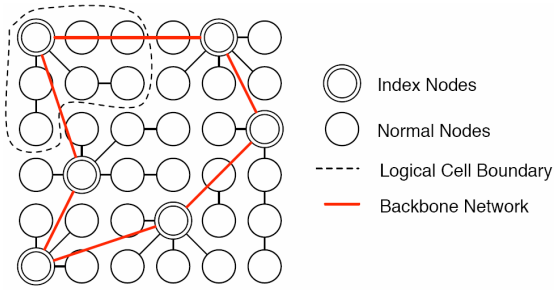
- **The Problem:**
  - Passive RFIDs require the reader to be within close proximity
    - Inefficient and slow: mobile reader must move around the warehouse
    - Not always possible

Solution Overview

- Add a level of hierarchy: on each crate an active tag gathers indexing data about all items
- Active tags form a peer-to-peer network, can gather data over the network
- Network is divided to cells
- Index nodes are selected and collect indexing data about a items in a cell, collection of index nodes form a *backbone network*
- To resolve a query:
  - Locate index node with data
  - Three choices:
    - — move the reader to data (more energy efficient)
    - — get data over the network (faster response)
    - — move the robot to a mid-point (trade-off between energy efficiency and response time)
- We must find the best course of action to resolve a query within a time constraint
- **Design goals:** energy and memory efficiency, low delay and adaptivity

Backbone Formation

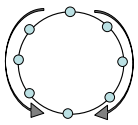
- Modified leader election algorithm used to select index nodes, selection depends on: available memory and residual energy
- Nodes are organized into "cells" of nodes with a common index
- Cells are organized as a tree, makes data gathering easier



- Form a network of index nodes to improve query processing efficiency, ring topology for simplicity
- Algorithm relies on location information to quickly and easily create a ring
- Index nodes exchange location information using directional flooding
- The algorithm completes with a node running a ring formation algorithm and distributing the results

Query Resolution

- Query Types: **Simple Query:** Answer from one node. **Complex Query:** Answer expected from multiple nodes
- Each query is associated with a time constraint ***T*** in which it needs to be resolved
  - For real-time applications ***T*** is set to small value: answer is transmitted over the network for minimal delay
  - Non-real-time applications can choose any value for ***T***



Resolving Simple Queries

- Locate data source by sending the query over the backbone
- Data source send the answer if small otherwise send a response containing answer size
- Response message collects information about intermediate nodes (between the data source and the mobile reader)
- Mobile reader uses its knowledge and the information from the message to decide on a point to collect the data from that will minimize the energy consumed while satisfying the time constraint

Resolving Complex Queries

- Locate data sources by sending the query over the backbone
- Data sources send response message with the answer size and their locations
- Mobile reader uses its knowledge if warehouse layout and the locations of all data sources to select a data fusion node
- Data sources send their answers to the fusion node
- Mobile reader moves to the fusion node and collect data

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