Title
The ACQUIRE Project

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The ACQUIRE Project
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Introduction

- ACQUIRE is a research project at the University of Southern California investigating data centric active querying in wireless sensor networks. It is funded by the National Science Foundation under NeTS-NOSS grant award number 0435505 (September 2004-August 2007).
- The goals of the project are to develop a novel framework and component protocols for scalable querying and resource discovery in next generation wireless sensor networks.
- Research Foci: Query Guidance, Analysis and Optimization of Querying, Secure Querying

Motivation

- Every physical event produces a fingerprint
- Usually follows diffusion laws
- Exploit this FREE natural information gradient repository
- Query routing and aggregation
- Handle noisy information gradient

Proposed Mechanisms

- RUGGED – A fully distributed greedy mechanism for query routing
  - Uses braided multiple path
  - Works with/without existence of gradient information
  - Resilient to node failure and lossy wireless links
- Information gradient-based on-demand query mechanism
  - Uses reusable virtual grids based on query parameters
  - With the leverage of geographic information
  - Allows complete search and on-demand aggregation
  - COUNT, MAX and MIN queries
- Complex queries

J. Faruque, Jung-Hyun Jun, Shyam Kapadia, Yongjin Kim, Sundeep Pattem, Sapon Tanachaiwiwat, Marco Zuniga - Allows complete search and on-demand query mechanism
- Uses braided multiple-path
- Handles noisy information gradient

Gradient-Based Querying

Motivation

- Can get reduction of query costs with more replicas, at the expense of higher replication costs
- What is the optimal replication strategy to balance these costs?

Approach

- Derive expressions for query and replication cost as a function of replication count
- Formulate as an optimization problem with and without storage constraints

Results

- Optimal strategy is to create number of replicas proportional to square root of query
- Query efficiency is a function of storage constraints


Querying with Replicated Data

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Research Foci: Query Guidance, Analysis and Optimization of Querying, Secure Querying

Correlation Analysis

Motivation

- WSN may require high level of data integrity
- Data aggregation in WSN is susceptible to large number of data insertion

Approach

- Characterize normal, abnormal (interesting) findings or malicious events based on statistical analysis from observed phenomena

- Promising accuracy in detecting large insertion attack (only 10% false negative) based on data from the Great Duck island project


Attacker Searching

Motivation

- Attacks in WSN (e.g. DOS)
- Attacker search/query is an important security function to detect attack origin
- Existing IP traceback schemes (e.g., iTrace, etc) are not directly applicable due to nature of WSN

Approach

- Protocol abnormality detection/characterization
- Directional query for the abnormality searching
- Abnormality matching to detect attacker

S. Patten, B. Krishnamachari, K. Pournis, “Analyzing Random Walk Techniques in Querying for Unstructured Data.” In Preparation

Self-Avoiding Random Queries

Motivation

- Random walk provides baseline for query performance
- Weekly Self-Avoiding Walks (WSAW) are random walks with k-step node avoidance memory
- WSAW can be useful where
  - there is little or no information to guide query
  - in the seek phase of ‘seek and focus’ type strategy

Results

- A memory of 3 steps reduces hitting, partial cover times (hence query costs) by half compared to a simple random walk
- Not much additional gain for memory > 3 steps
- Thus, significant efficiency gain is possible for very low overhead