A Quick and Reliable Routing for Infrastructure Surveillance with Wireless Sensor Networks

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Outline

- Introduction
- Target Problem
- Our Approach
- Experimental Results
- Conclusion & Future Work

Introduction

- Mission-critical application of infrastructure surveillance
  - Detect and respond in an extremely short time frame
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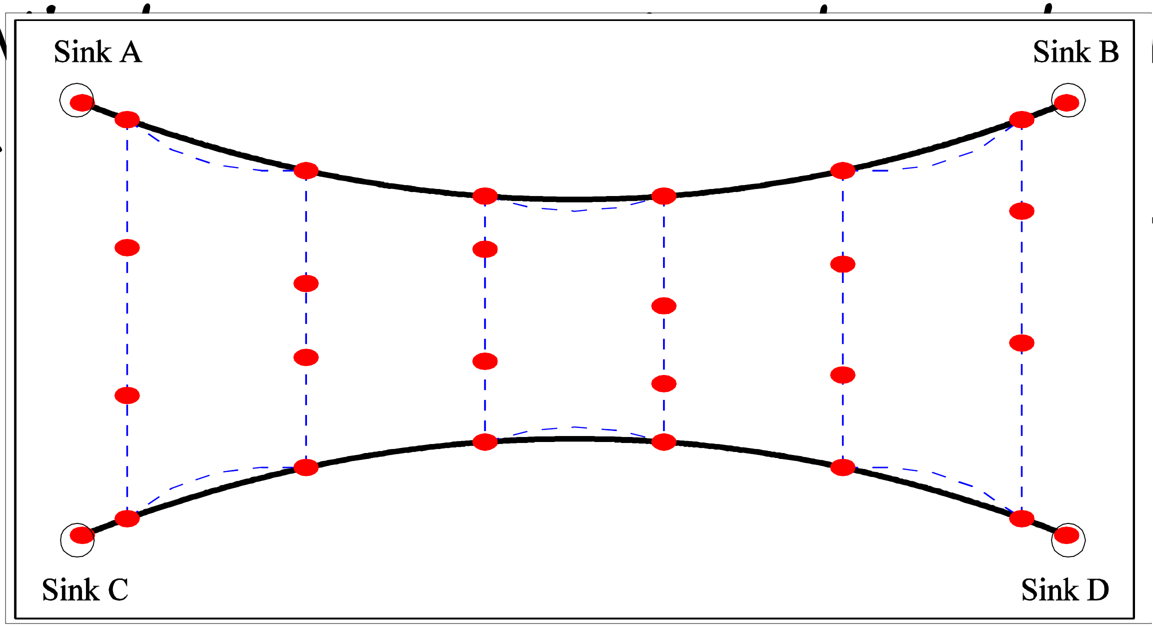
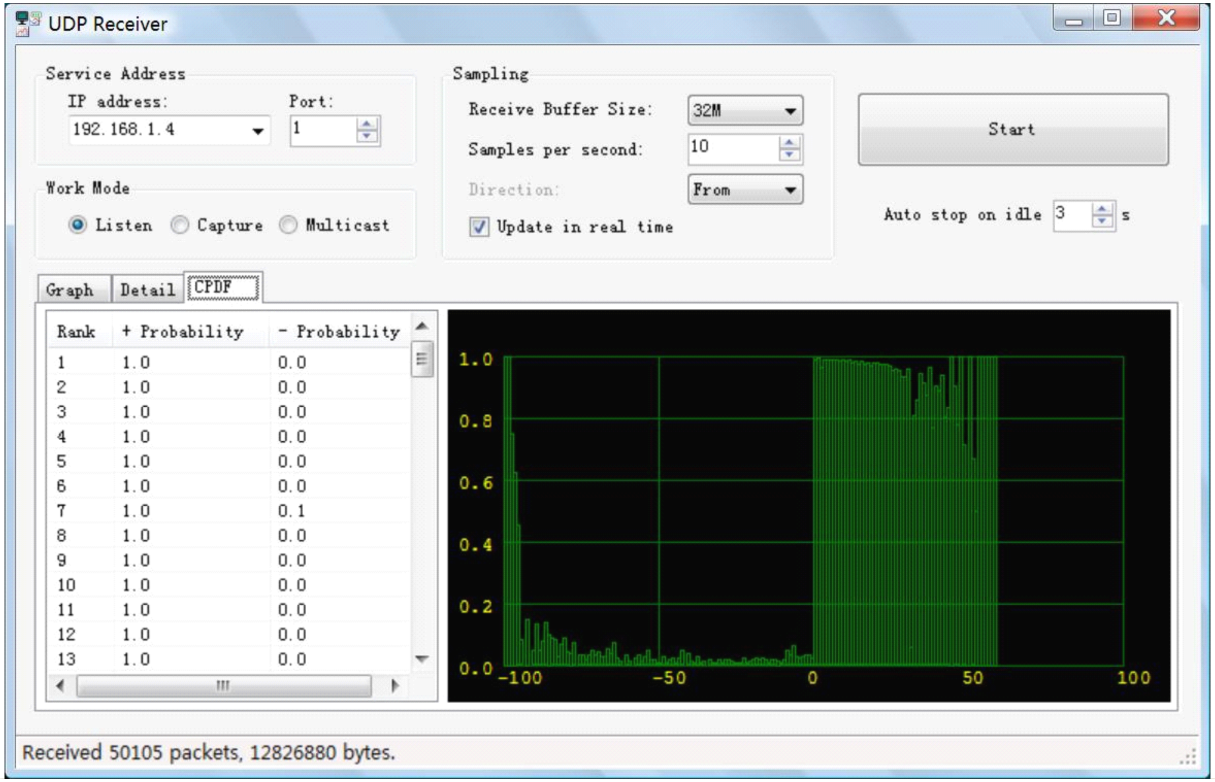


- Link Burstiness
  - Each link's transmission has its uncertainty
  - CPDF measurement
    - A link with a string of consecutive successes or failures has a relatively stable quality for the successor selection in the upcoming relay.



The problem is not trivial!

- How many (re-)transmissions are needed to move the message at least 1-hop advance (i.e., greedy forwarding) along the shortest path?

mean, not for individual case

Synchronous (round-based)

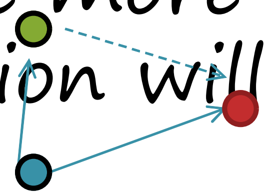
- How to find the path with the minimum number of retransmissions in the dynamic networks?
- √ How to find the quickest path with the consideration of
  - Hop distance
  - Schedule delay (cycle waiting time, when to initiate the transmission)
  - Transmission delay (how long to successfully receive the signal from rely neighbor)

Target Problem

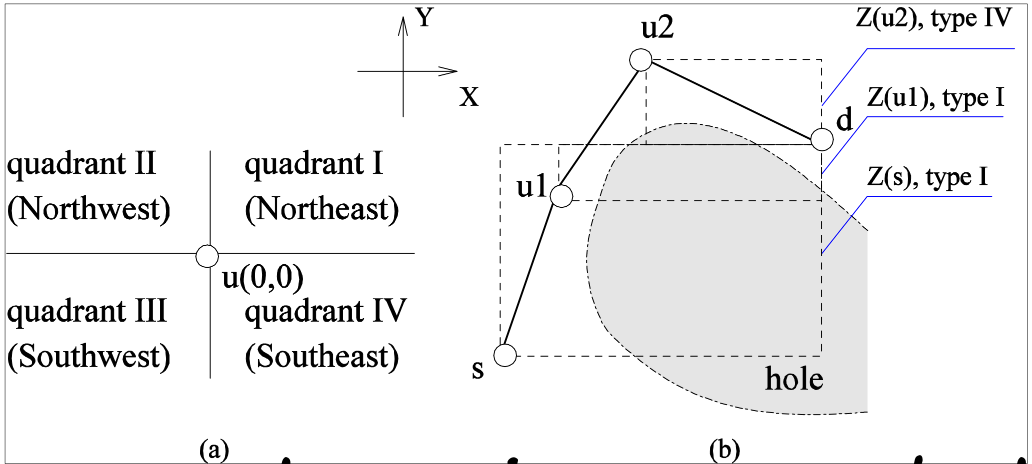
- How to determine the mutual impact of link burstiness on other factors of end-to-end delay?
  - Weight?
- Whether is a failed transmission worthy to retry?
  - In the global view
  - Upon dynamic configuration changes
- How many retransmission are allowed along a path?

Our approach

- Estimate delay cost.
- Selection of a forwarding successor with a relatively better performance (less delay) in our measurement.
- Approach to the destination gradually in a greedy manner (in terms of end-to-end delay).
- The closer the routing approach the destination, the more accurate the successor selection will be.



- Each node has four regions



- For each region, a node has a normalized metric value M (where 1/M indicates delay to reach the edge of network in this region): $1/M(u) = R_{(u,v)} x C_{(u,v)} +$

Routing (u, v, d)

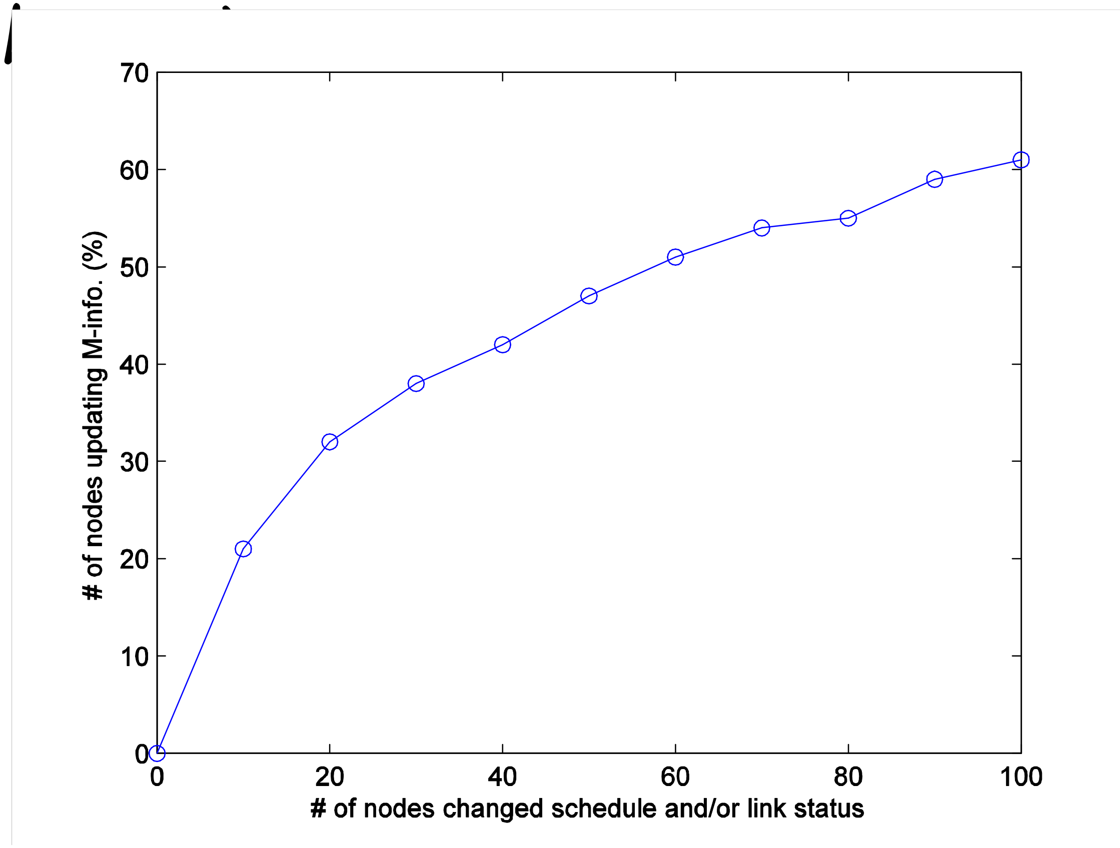
- If $d \in n(u)$, $v = d$.
- Determine all four request zones $Z_k(u)$ $(1 \le k \le 4)$.
- Transmission phase
  - Select $v \in N(u)$ where v has the highest M value (minimum 1/M).
  - Wait $R_{(u,v)} \times C_{(u,v)}$ until message is delivered.
- Otherwise, backup phase
  - If v miss the contact at the expected time, u switches to

Performance Analysis

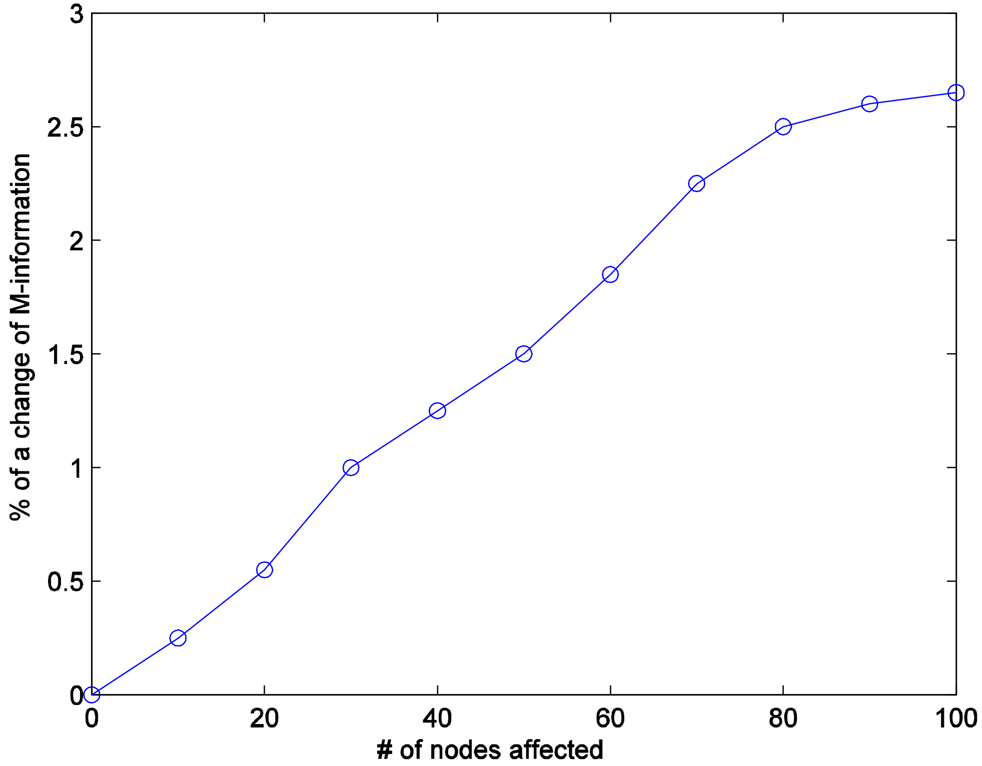
- No detour when M(s)>0.
- Information converged quickly.
- Keep effectiveness in SIMO model.
- The probability of a change of M: P(M) ~ k
  - when k is the number of links that have a burstiness out of the expectation in the CPDF and there is no cycle schedule change.
- P(M) ~ Sqrt{k}
  - when k is the number of nodes with new cycle schedules and there is no link change its quality described in the CPDF.

Experimental Results

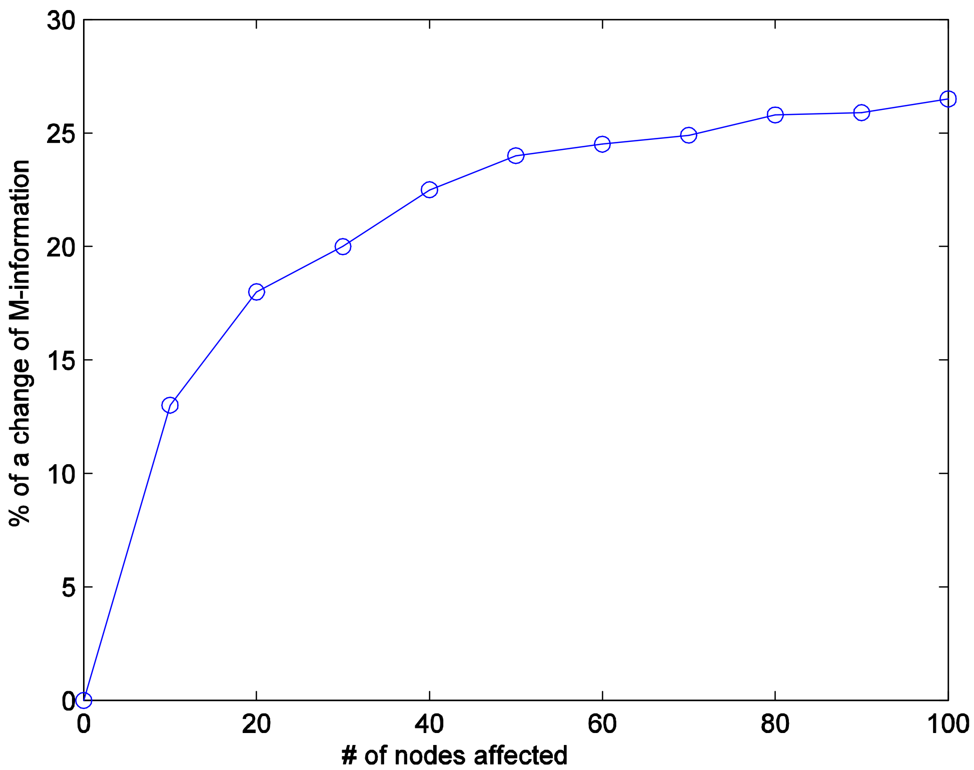
- Cost of information update (both cycle schedule change and link quality cl…



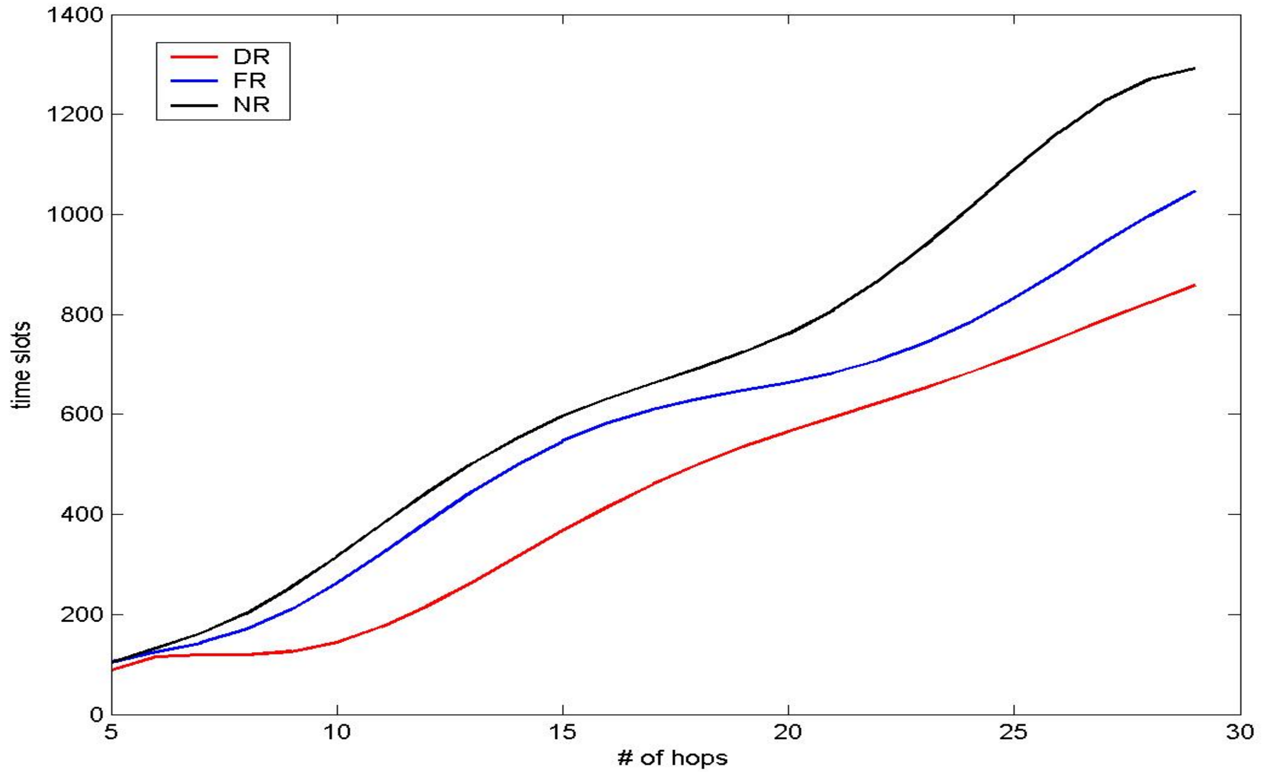
- Cost of information update (only link quality change)



- Cost of information update (only cycle schedule change)



- Duty cycle system (10%)
  - Non-reservation, anycasting (NR)
  - Fixed-reservation, 30% additional time, not for individual case (FR)
  - Dynamic-reservation, with CPDF (DR)



Conclusion

- Some fresh insights of link burstiness vs.
  - Channel reservation
  - End-to-end delay performance
- A practical estimation solution with the consideration of the computational complexity and cost

Future Work

- Other constraints such as energy cost
- Cycle schedule to mitigate the impact of link burstiness
- Extension in MIMO model (e.g., from greedy procedure to parallel processes with Nash equilibrium based fairness)

Thank you!

- Questions and Comments