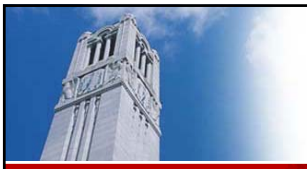

NC STATE UNIVERSITY Computer Science

Mitigating Routing Misbehavior in Mobile Ad-Hoc Networks

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CSC774 Network Security

Overview

- "Mitigating Routing Misbehavior in Mobile Ad Hoc Networks", Sergio Marti, T.J. Giuli, Kevin Lai, and Mary Baker, MobiCom 2000
- Introduces two techniques that improve throughput in an ad hoc network in the presence of "misbehaving" nodes.

Outline

- Background
  - Ad-Hoc Networks
  - Routing in Ad-Hoc Networks
- Dynamic Source Routing Extensions
  - Watchdog
  - Pathrater
- Simulation Results
- Related Work
- Future Work and Conclusions

Background: Ad-Hoc Networks

- Collection of wireless mobile devices
- Vulnerabilities
- Misbehaving Nodes
- Solutions
- Routing Issues

Background: Routing in Ad-Hoc

- Two categories:
  - Table Driven
    - Nodes maintain routing tables
    - Broadcast updates
  - On Demand
    - Routes created only when needed
    - Routes expire or removed

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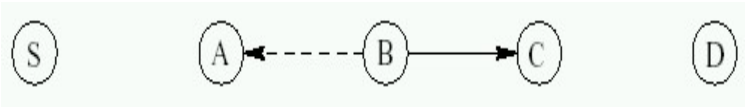
Dynamic Source Routing

- On Demand routing
- Nodes maintain a route caches
- Route Discovery Phase
  - If not found in cache, broadcast a route request packet
  - Destination sends a route reply
- Route Maintenance Phase
  - Error packets
  - Acknowledgments

Dynamic Source Routing Extensions: Watchdog

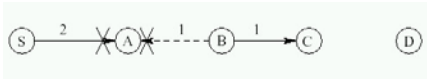
- Identifies misbehaving nodes
- Maintains a buffer of transmitted packets
- Monitors next hop node's transmission



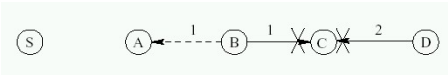
- Increments a failure tally for the nodes

Dynamic Source Routing Extensions: Watchdog cont'd

- Watchdog Weaknesses
  - Ambiguous collisions



  - Receiver collisions



  - False misbehavior reporting
  - Limit transmission power
  - Collusion
  - Partial dropping

Dynamic Source Routing Extensions: Pathrater

- Avoids routing packets through malicious nodes
- Each node maintains a rating for every other node
- A node is assigned as a "neutral" rating of 0.5
- The rating of nodes on all *actively used path* increase by 0.01 at periodic intervals of 200 ms
- The rating of nodes decrease 0.05 when a link break is detected
- High negative numbers are assigned to nodes suspected of misbehaving nodes by Watchdog

Dynamic Source Routing Extensions: Pathrater cont'd

- It calculates a path metric by averaging the node rating in the path
- If there are multiple paths, the node choses the path with the highest metric
- It increases the throughput
- It gives a comparison of the overall reliability of different paths
- It increase the ratio of overhead transmissions to data transmission

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Simulation Scenario

- Assumptions
  - Bidirectional communication
  - Wireless interfaces that support promiscuous mode operation
- Setup
  - 50 nodes in various states of mobility
  - Created 4 different extension scenarios (WD, PR, SRR)
  - Varied misbehaving nodes 0% to 40%

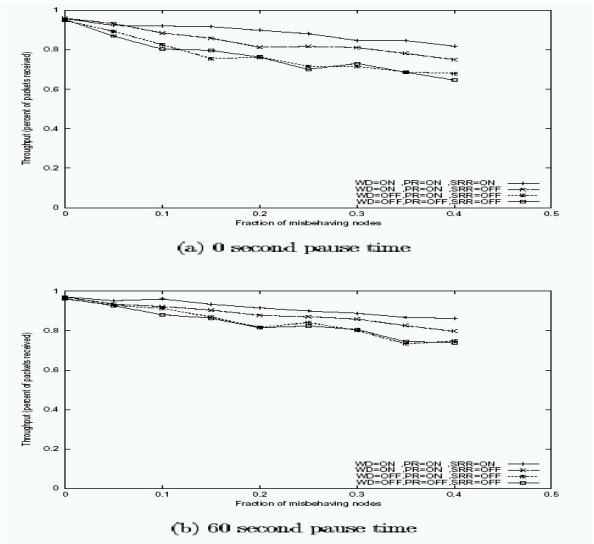
Simulation Metrics

- Evaluation done on three metrics:
  - *Throughput*: % of sent data actually received by the intended destinations
  - *Overhead*: Ratio of routing-related transmission to data transmissions
  - *Watchdog False Positives*: The impact when watchdog mistakes a node as misbehaving

Simulation Metrics: Throughput

- Best performance when all three extensions were active
- Pathrater isolated in one test
- Pathrater alone does not affect performance

Simulation Metrics: Throughput



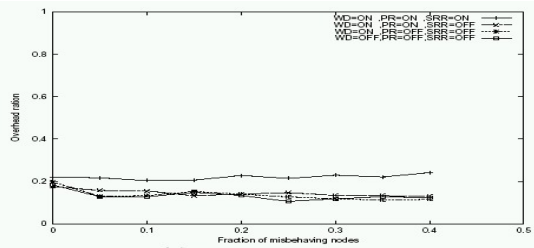
(a) 0 second pause time

(b) 60 second pause time

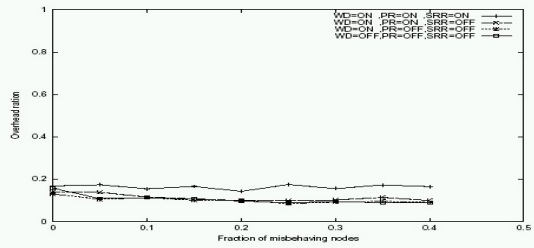
Simulation Metrics: Overhead

- Increased overhead
- Watchdog isolated in one simulation
- Watchdog alone adds a little overhead

Simulation Metrics: Overhead



(a) 0 second pause time



(b) 60 second pause time

Simulation Metrics: False Detection

- Demonstrated how throughput is effected with the reporting of False Positives
- Throughput does decrease but could result in beneficial side effects:
  - Helps determine unreliable nodes
  - Ambiguous collisions may help increase throughput
  - Nodes maintain a fresher route cache

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Related Work

- No significant related work before publication date in 2000.
- DSR, AODV, TORA, DSDV, STAR only detect if the receiver's network interface is accepting packets.
- Some recent related work:
  - T. GoffNael, B. Abu-Ghazaleh, D. S. Phatak, and R. Kahvecioglu, "Preemptive Routing in Ad-Hoc Networks," presented at Seventh annual international conference on Mobile computing and networking, 2001.
  - Y.-C. Hu, A. Perrig, and D. B. Johnson, "Adrianne: A Secure On-Demand Routing Protocol," presented at Eight Annual International Conference on Mobile Computing and Networking, Atlanta, GA, 2002.
  - B. Awerbuch, D. Holmer, C. Nita-Rotaru, and H. Rubens, "An On-Demand Secure Routing Protocol Resilient to Byzantine Failures," presented at ACM Workshop on Wireless Security, Atlanta, GA, 2002.

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Future Work

- Expand on how the threshold values could be optimized
- Implementation of a priori trusted relationships
- Detection of multiple node collusion

Conclusions

- Ad hoc networks are vulnerable to nodes that misbehave when routing packets
- Simulation evaluates that the 2 techniques
  - increases throughput by 17% in network with moderate mobility, while increase ratio of overhead to data transmission from 9% to 17%
  - increases throughput by 27% in network with extreme mobility, while increase ratio of overhead to data transmission from 12% to 24%

Thank you.

- Questions…