Delay Tolerant Network Routing

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Overview of Talk

- Background

- Research Objective
  - Performance analysis
  - Message Prioritization

- Simulation Study
  - Results

- Future Plans
Delay Tolerant Network Routing

- Traditional networks
  - Route from source to destination exists when the message leaves the source

- Delay tolerant networks
  - No pre-existing route
  - Message is forwarded as nodes encounter each other
    - Message traverses the route over time as the nodes move around
Delay Tolerant Network

Node A wants to transmit to Node E
Delay Tolerant Network

Node A will transmit to Node B

Node B will encounter Node C and transmit data

Node C will encounter Node D and transmit data

Data will be successfully delivered
Routing Protocols

- This research focuses on two routing protocols
  - **Epidemic Routing**
    - Forward message to every node encountered
    - Message spreads like that of a disease in a population
  - **ProPHET**
    - Probabilistic Routing Protocol using History of Encounters and Transitivity
    - Use past encounters to predict future best route
    - Provides a framework allowing for different forwarding decision algorithms
Research Objective

- **Message Prioritization**
  - Use the insights gained from analysis to develop message prioritization algorithms for DTN routing

- **Performance analysis**
  - Develop analytical and simulation models to study three related performance parameters
    - Duplicate messages in the network at the time of delivery
    - End to end latency of message delivery
    - Probability of message delivery
Current Status

- Developed four types of ProPHET forwarding decision algorithms
- Developed a simple probabilistic extension to Epidemic ($q – $Epidemic)
- Extensive simulation analysis of Epidemic vs ProPHET routing using ONE (Opportunistic Network Environment Simulation tool)
Results

- A lot of data collected
- Some insights:
  - $q = 0.5$ Epidemic has similar performance as ProPHET without all the complexity when Random Waypoint Mobility is used
  - Aggressive algorithms have low latency at low message generation rates
  - We haven’t seen any consistent performance improvement by ProPHET when there is any randomness in the mobility pattern (More simulations are being run as we speak)
Results

- Insights continued:
  - Variables that impact the latency are:
    - Message generation rate
    - Queue length
    - Number of nodes
    - Aggressive vs non-aggressive algorithms
## Sample Results

### 10 Nodes

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Conclusion

- Throttling Epidemic behavior using a q value seems to work well
- Mathematical analysis based on the input variables is needed
  - Work in progress
- Few levers available to affect message prioritization at routing
  - q value for Epidemic
  - Limit on the number of hops
  - Prioritization within queues
Two Related Recent Projects

- Experimentation with Simple Message Prioritization Extensions to ProPHET
  - NPS Master Thesis (March 2011, LT Rapin, USN)

- Secure Distributed Storage for Mobile Devices
  - NPS Master thesis (March 2011, LT Huchton, USN)
  - Upcoming MILCOM paper
Experimentation with ProPHET Message Prioritization

- Simple extensions (with two traffic priority classes) can increase the performance of high priority messages significantly
  - Higher message delivery rate
  - Lower message latency
- Urgent need of stable software prototypes to advance DTN research beyond theory and simulations
  - The current IRTF DTN2 reference implementation is of very low quality
A Secure Distributed File System for Mobile Devices

- Resistant to total device compromise
  - Up to a customizable number \( (k) \) of device captures
  - No need for specialized tamper-resistant hardware
  - Addressing limitation of “Remote Kill”

- Group secret sharing also supports data resiliency
  - Different collection of \( k \) devices can recover data

- Prototype on Android 2.2 Smart Phones
  - write() and read() throughput performance: up to 15 Mbps
Backup Slides
Fig. 4. Average Executive Times (ms) for 1MB file