Friendships in the Air: Integrating Social Links into Wireless Network Modeling, Routing, and Analysis

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Outline

• Motivation
  - Exploratory research on combining social and wireless communication links

• Assumptions and Modeling
  - Greedy routing
  - Success delivery probability and delay

• Small-scale experiments
  - Setups
  - Results

• Conclusion and limitations
Communication networks today

• Today’s infrastructure based network
  - Cellular network
  - Satellite network

• Peer-to-peer based network, ad-hoc network
  - WiFi
  - bluetooth
Social Networks vs Physical Networks

- Social link
  - Logical link, does not physically exit
- Today’s communication network provide a communication medium for social connections

Friends talking using phones
Social links overlaid over wireless networks

- On the upper layer, we can think data is delivered over social links.
A highly abstract model

• Combined social and wireless network
  - A hybrid network consisting of
    • Social links
    • Wireless links

• Both links can be used to deliver data
Potential Application

• Exploratory research
  - Combining social and communication networks
  - Analyzing information dissemination over joint network structures.

• Potential applications:
  - Emergency broadcasting
  - Optimized message delivery
Example: Emergency broadcasting

Social link

Peer-to-peer wireless link

When B can get the message?
How to send a message: example
Greedy Routing

- In all of social link and communication link neighbors, attempt to find the next-hop node in neighbors, whose distance to the destination is the shortest.
Coupling between social & comm. links

• We capture correlation between social and communication links in modeling, analysis and experiments.

Correlation probabilities (according to Octopus model)
Approximation

• **Distance discretization**
  - get iterative solutions of delivery success probability and delay
Emulation Testbed Setups

- SVT: Surrogate Virtual Transmitter
- SVR: Surrogate Virtual Receiver
Emulation Testbed Picture

- Router stations
- SVT
- SVR
- Ethernet Switch
- RFnest
Components

- **RouterStation Pro:**
  - WiFi, Ethernet interfaces
  - Running as a node

- **WiFi**
  - Wireless links

- **Ethernet**
  - Emulated social link controlled by social network server
RFnest: Multi-hop wireless channel emulator

Using RF cables connected to stations, RFnest accepts real RF signals and applies digitally controlled channel effects to RF signals.
Visualization
Experiments: Success Probability

Theoretical: $\beta_s = 90\%, \beta_c = 95\%$

Experimental: $\beta_s = 90\%, \beta_c = 95\%$

Theoretical: $\beta_s = 40\%, \beta_c = 30\%$

Experimental: $\beta_s = 40\%, \beta_c = 30\%$
Greedy Routing

- Greedy routing: always move a message closer to the destination.
- Longer distance $\Rightarrow$ more likely to find a next-hop node with social link directly connected to the destination.
Experiments: Delivery Delay

- Theoretical: $\beta_s = 90\%, \beta_c = 95\%$
- Experimental: $\beta_s = 90\%, \beta_c = 95\%$
- Theoretical: $\beta_s = 40\%, \beta_c = 30\%$
- Experimental: $\beta_s = 40\%, \beta_c = 30\%$
Conclusions

• Investigated the design of combining the social and wireless network.

• Small-scale experiments
  - Success probability is always bounded from below, as distance goes to infinity.
  - Average delivery delay is always bounded from above, as distance goes to infinity.

• Limitations:
  - How this model should work in practice.
  - Knowledge in routing, mobility, ...