Socio-Technological Communication Testbed for Mobile Social Networks

Zhuo Lu, University of Memphis
Yalin Sagduyu and Yi Shi, Intelligent Automation Inc.
Outline

• 1. Motivations of Socio-Technological Communication Network Research

• 2. Experiment Setups

• 3. Data Delivery and Routing in Socio-Technological Communication Network

• 4. Experimental Results
Common network links existing 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 network experiments

Mail experiment (Milgram, 1969)  Email Experiment (Watts, 2003)

Given a target individual and a particular property, pass the message to a person you correspond with who is “closest” to the target.

Short chain lengths – six degrees of separation

Typical strategy – if far from target choose someone geographically closer, if close to target geographically, choose someone professionally closer
Social links overlaid over wireless networks

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

• **Socio-Technological Communication 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
  – Secure key establishment
Emergency broadcasting

Social link

Peer-to-peer wireless link

Emergency!

When B can get the message?
Secure Key Establishment

• A wants to communicate with B
• A: I can send data to you as a forwarding node to reach B only if
  – I can see you (in one-hop communication distance)
  – I know you (has a social link)
Goals

• Design and study
  – experimental/emulation testbeds for combined social and wireless network

Communication network testbeds
CORNET (Vtech), ORBIT (WINLAB), Emulab (Utah), ...

Social media and Social networks
Testbed Setups

• SVT: Surrogate Virtual Transmitter
• SVR: Surrogate Virtual Receiver
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
Social Network Server

- Maintaining social connections from MIT RealityMining Data Set
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.
Wireless Network Emulation with RFnest

- RFnest controls attenuation, interference, multipath and Doppler effects.

- RFnest supports seamless integration of real nodes (actual radios) and virtual nodes (simulated nodes) for additional scalability.

**Specifications at a glance:**

- **Number of Ports:** 8 to 96
- **RF Configurations:** MIMO, SISO, SIMO, MISO, MESH
- **Frequency Band:** 0 Hz to 6 GHz (model dependent)
- **Maximum Propagation Delay:** 2 seconds
- **Doppler Shift:** up to 200kHz
- **Fading Profiles:** Rayleigh, Rician, Pure Doppler, Freq/Phase Shift, Log-normal Fading
- **Interference Generator:** Independent per channel
Control Panel for the Testbed
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 & communication links

- We capture correlation between social and communication links in modeling, analysis and experiments.
Distance between source and destination

- $d$ – the distance

Overall a very challenging question to get delay and delivery ratio! Get an analytical solution? Mission impossible!
Visualization
Experiments: Success Probability
Experiments: Delivery Delay

![Graph showing delivery delay](image-url)
Persistent Transmission: Success Probability

Graph showing the success probability of persistent transmission with different communication and social failure rates as a function of hop distance.
Persistent Transmission: Delivery Delay

![Graph showing delivery delay vs hop distance for different communication and social failure rates.]

- Blue line: 10% communication, 5% social failure
- Red dotted line: 60% communication, 70% social failure
Conclusions

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

• Built a socio-technological testbed to evaluate joint social and communication network design.

• 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.