Socio-Technological Communication Testbed for Mobile Social Networks

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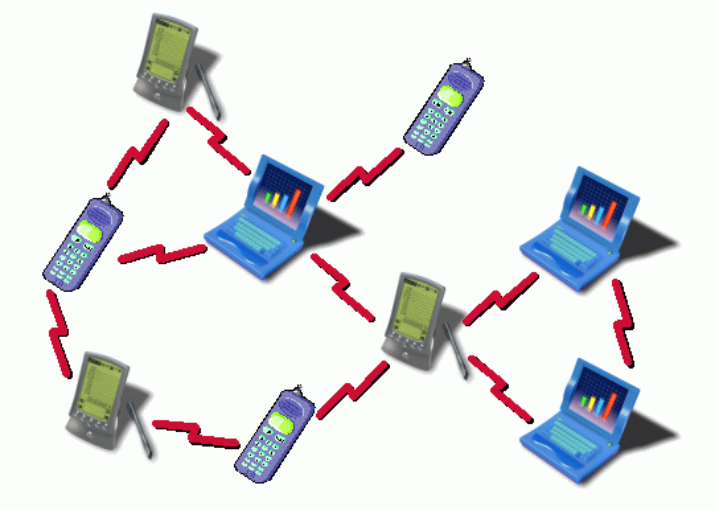
Outline

- 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

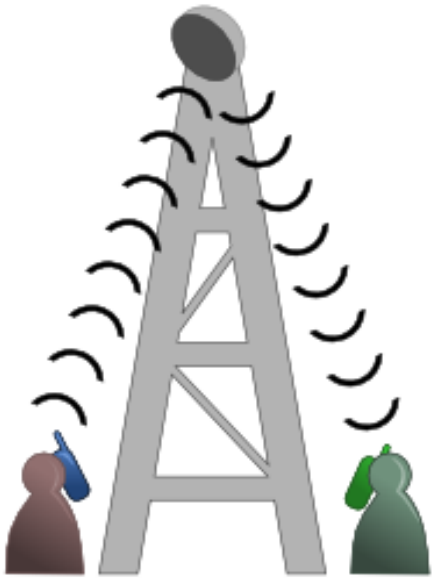
- **Today's infrastructure based network**
  - Cellular network
  - Satellite network

- **Peer-to-peer based network, ad-hoc network**
  - WiFi
  - bluetooth



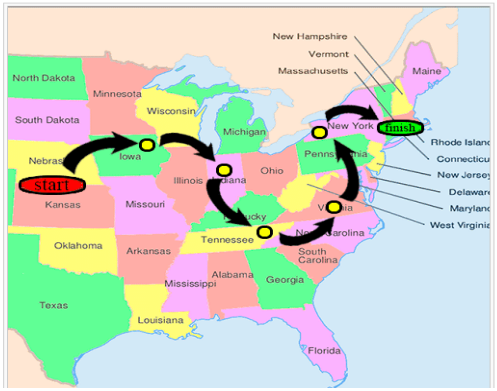
Social Networks vs Physical Networks

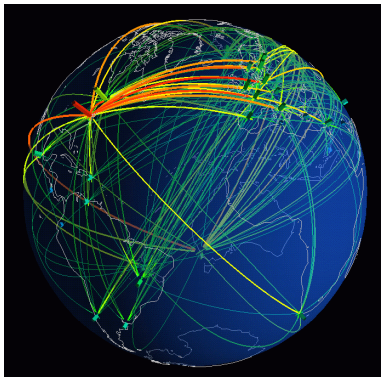
- **Social link**
  - Logical link, does not physically exit
- **Today's communication network provide a communication medium for social connections**



Friends talking using phones

Social network experiments





Mail experiment (Milgram, 1969)

Email Experiment (Watts, 2003)

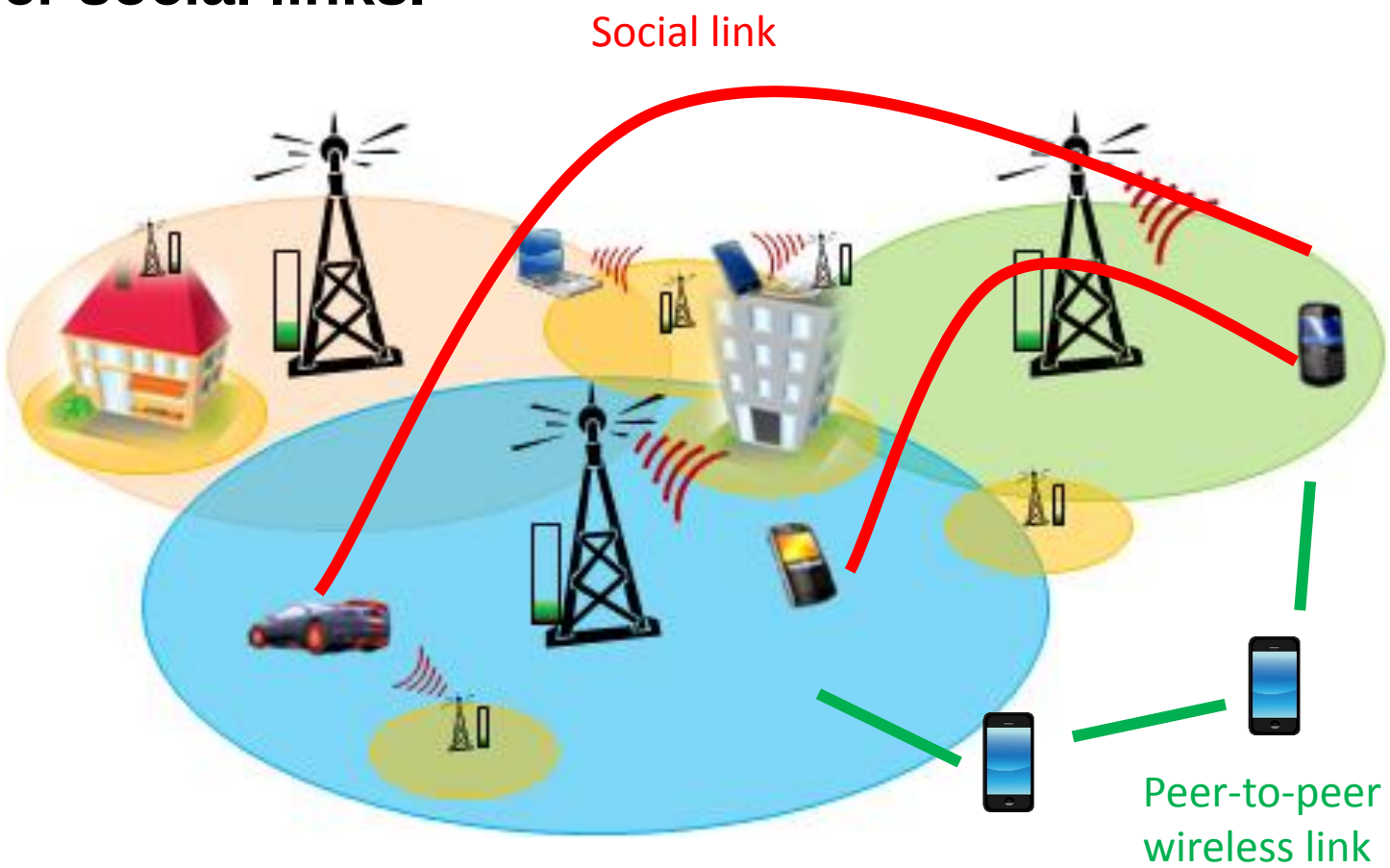
Given a target individual and a particular property, pass the message to a person you correspond with who is "closest" to the target.

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

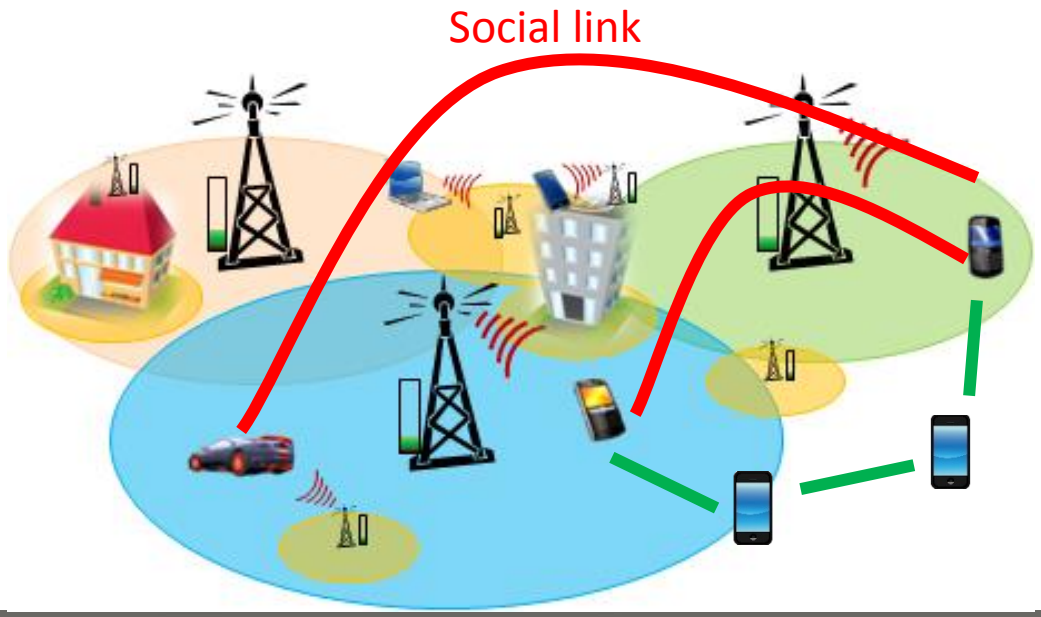
Social links overlaid over wireless networks

- **On the upper layer, we can think data is delivered over social links.**



A highly abstract model

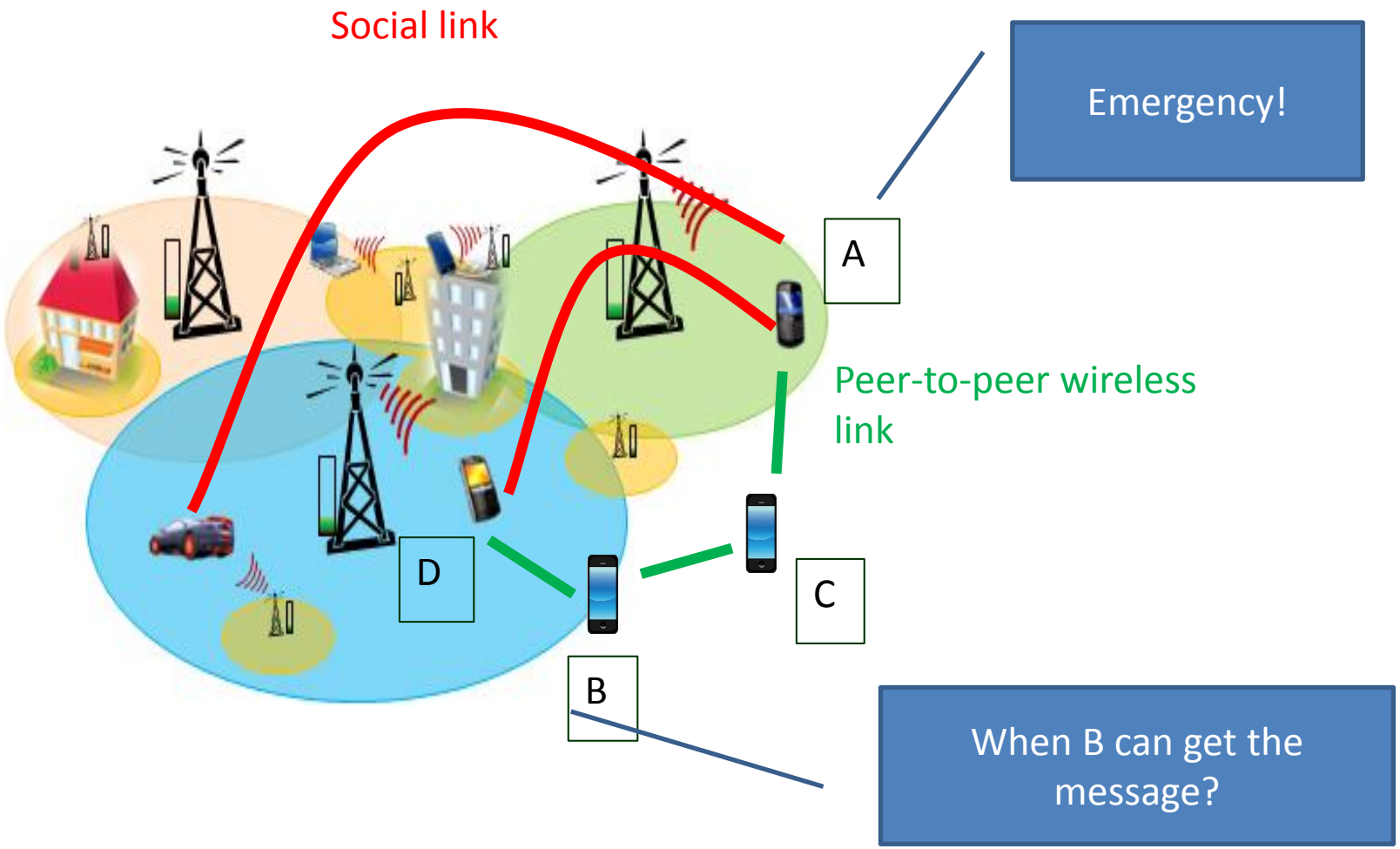
- **Socio-Technological Communication Network**
  - A hybrid network consisting of
    - Social links
    - Wireless links
- **Both links can be used to deliver data**



Potential Application

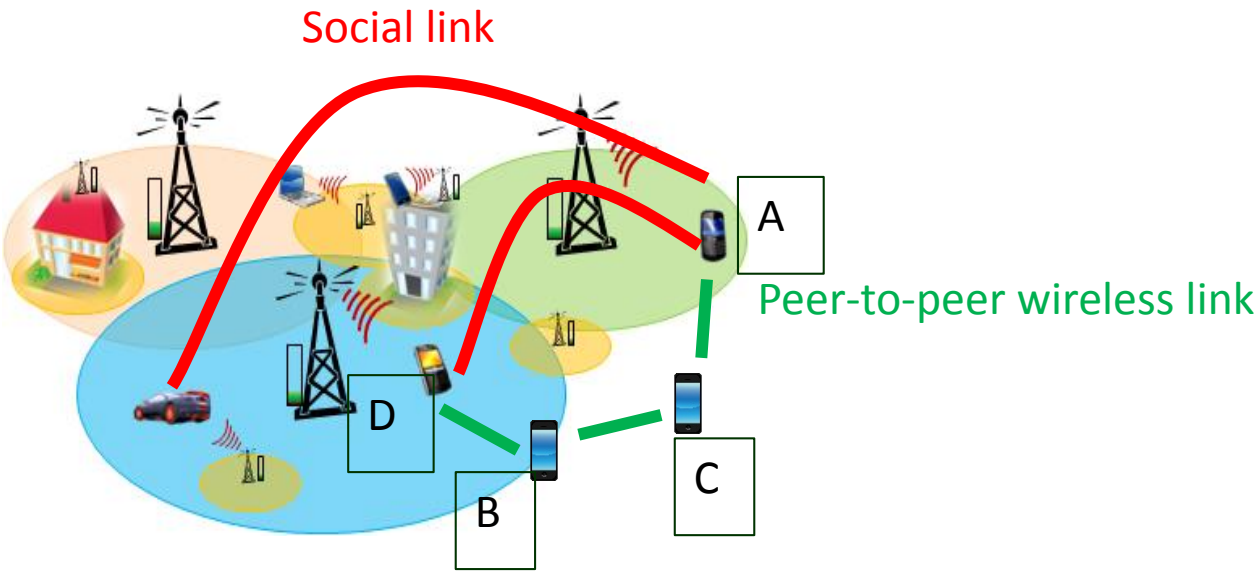
- **Exploratory research**
  - Combining social and communication networks
  - Analyzing information dissemination over joint network structures.
- **Potential applications:**
  - Emergency broadcasting
  - Secure key establishment

Emergency broadcasting



Secure Key Establishment

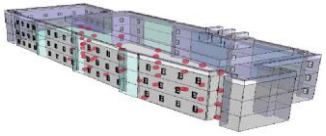
- **A wants to communicate with B**
- **A: I can send data to you as a forwarding node to reach B only if**
  - I can see you (in one-hop communication distance)
  - I know you (has a social link)



Goals

- **Design and study**
  - experimental/emulation testbeds for combined social and wireless network

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

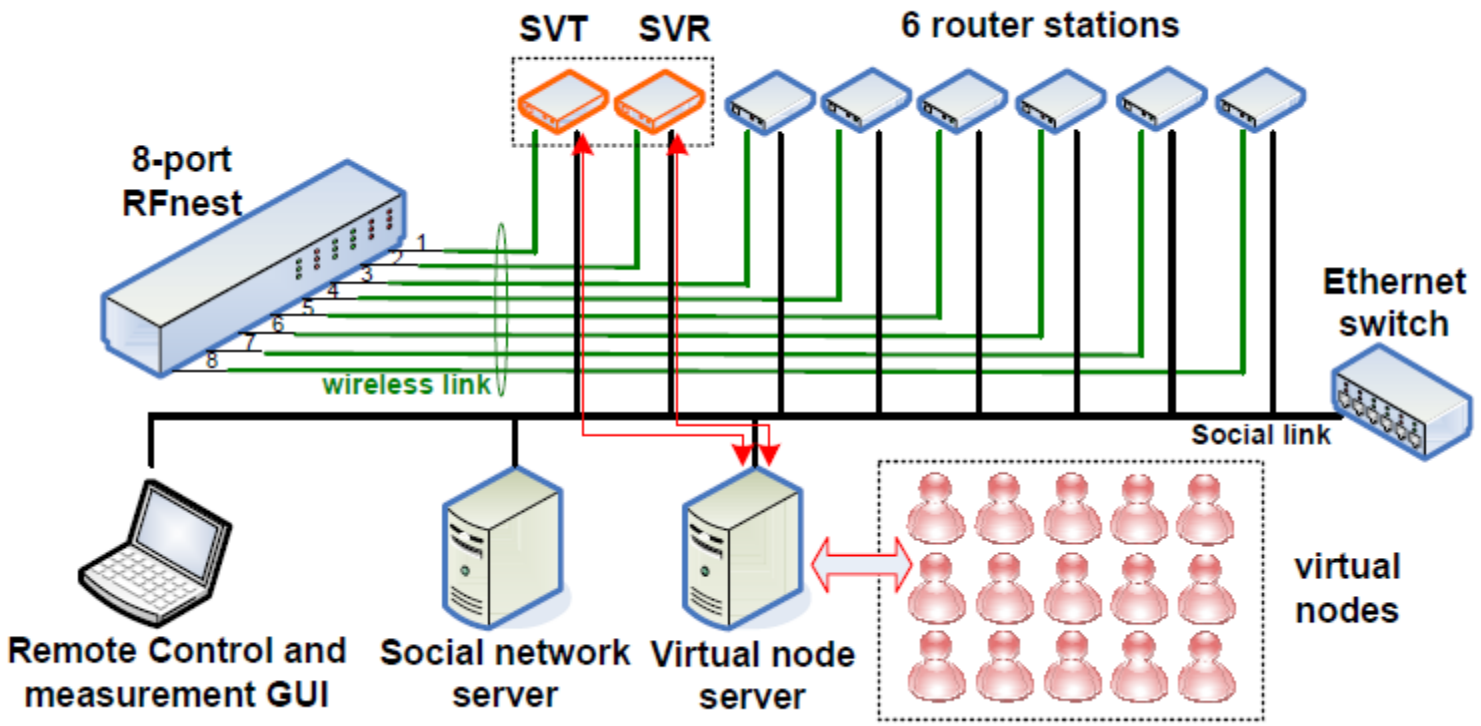


Social media and Social networks

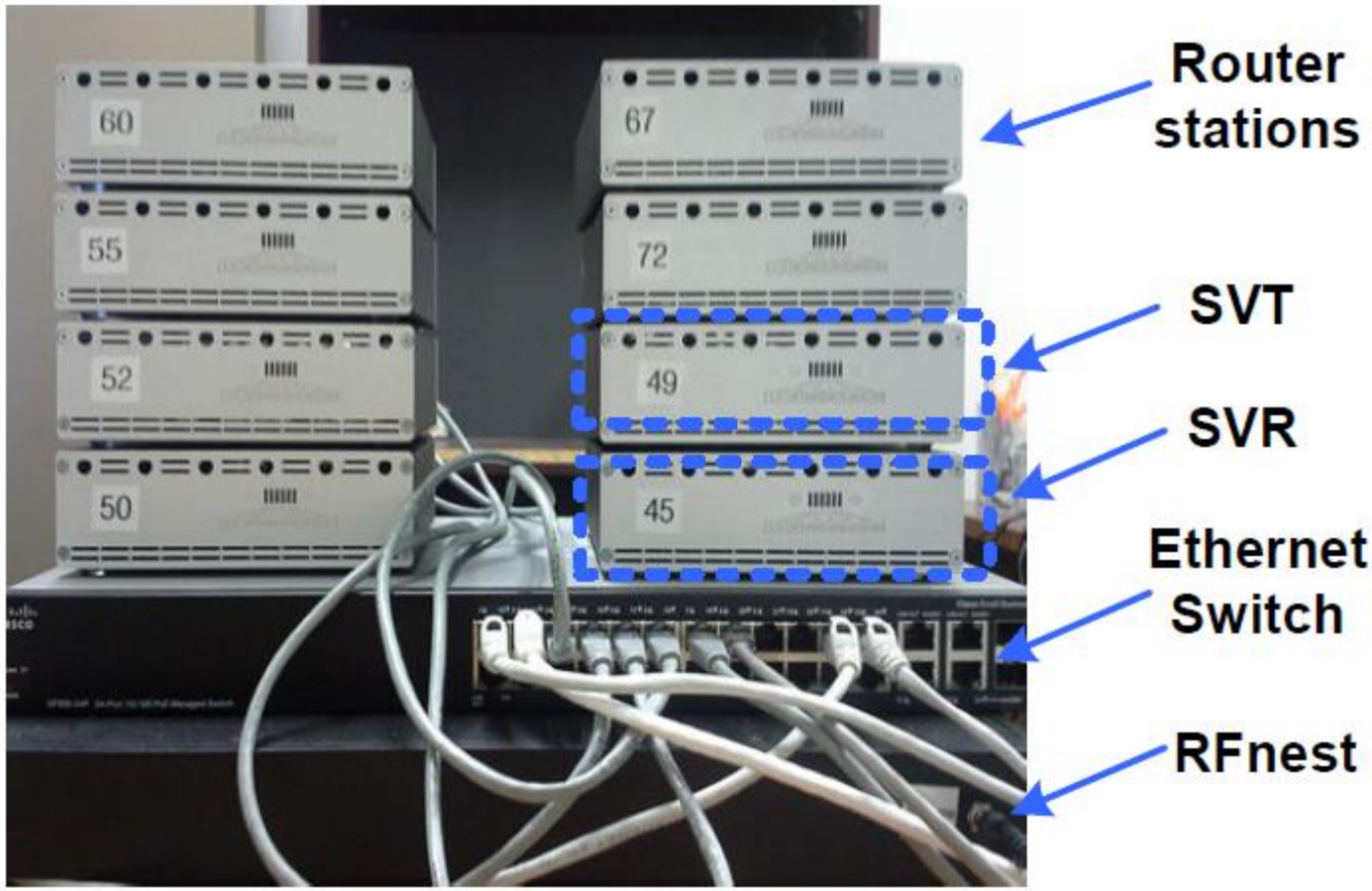



Testbed Setups

- SVT: Surrogate Virtual Transmitter
- SVR: Surrogate Virtual Receiver



Testbed Picture



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

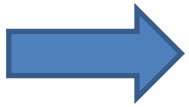
- **Maintaining social connections fro MIT RealityMining Data Set**

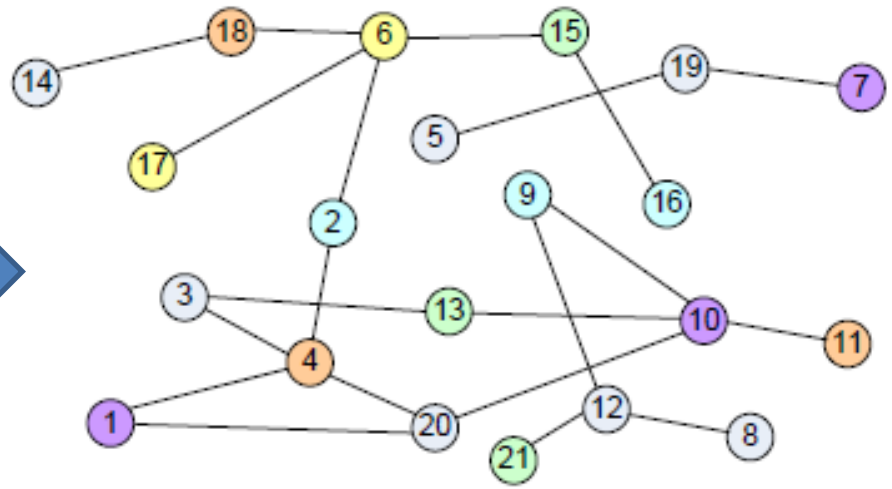
Reality Commons

brought to you by the MIT Human Dynamics Lab

Reality Mining Dataset - Data Breakdown

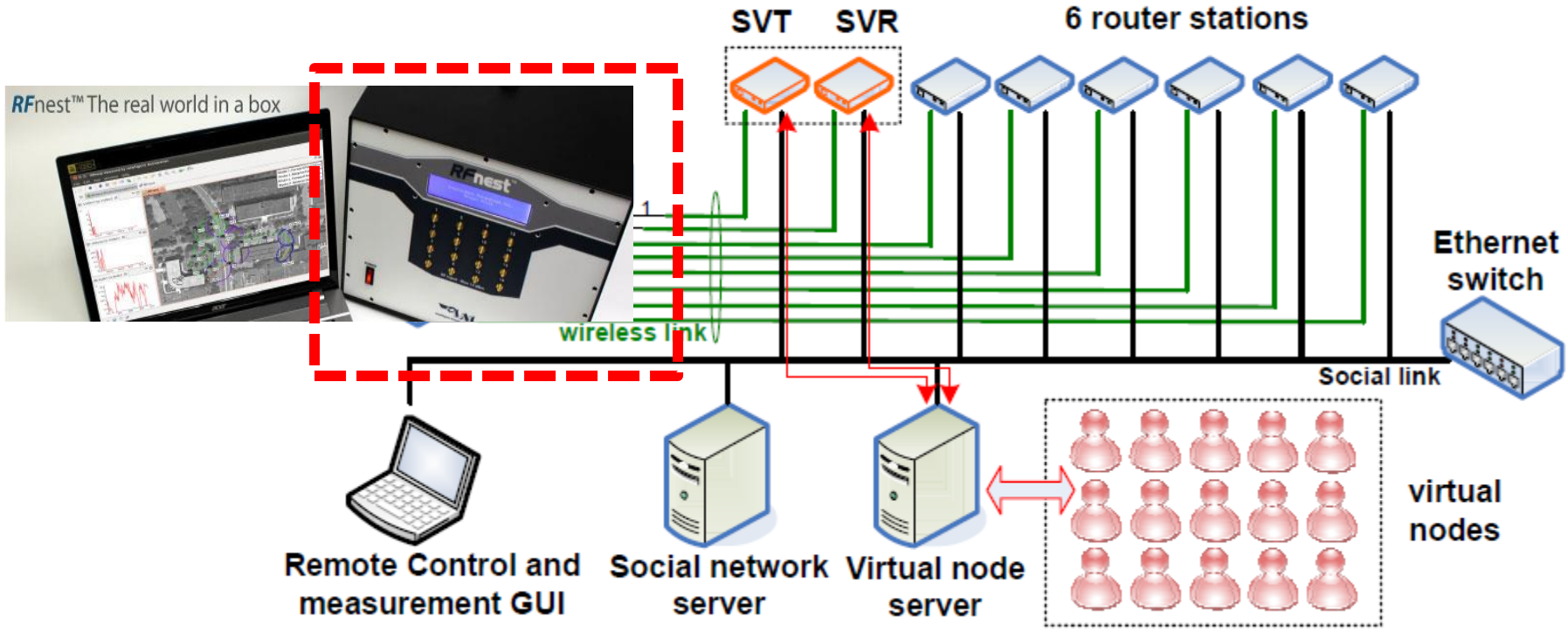
sensor data (temporal resolution 6 minutes)
proximity
location, location labels, latitudes and longitudes (spatial resolution, about 100 meters)
call log, sms: time with hourly resolution (or date + early morning/morning/afternoon/evening/midnight), duration, unique callee identifier (natural number)
running Nokia applications
survey data
perceived friendship
personal attributes
research group
position (graduate student, undergraduate student, staff, prof.)
neighborhood of apartment
lifestyle: when in the office, how often to travel, predictability of life, where to hangout, how often get sick.





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)

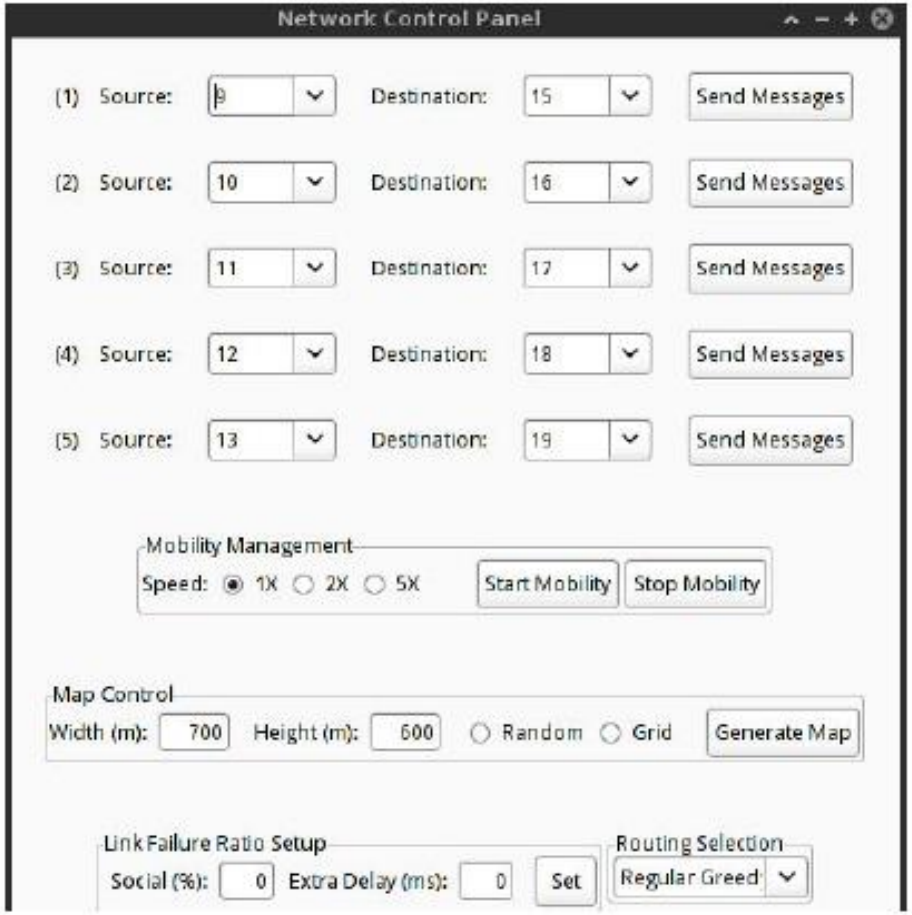
Maximum Propagation Delay:
2 seconds

Doppler Shift:
up to 200kHz

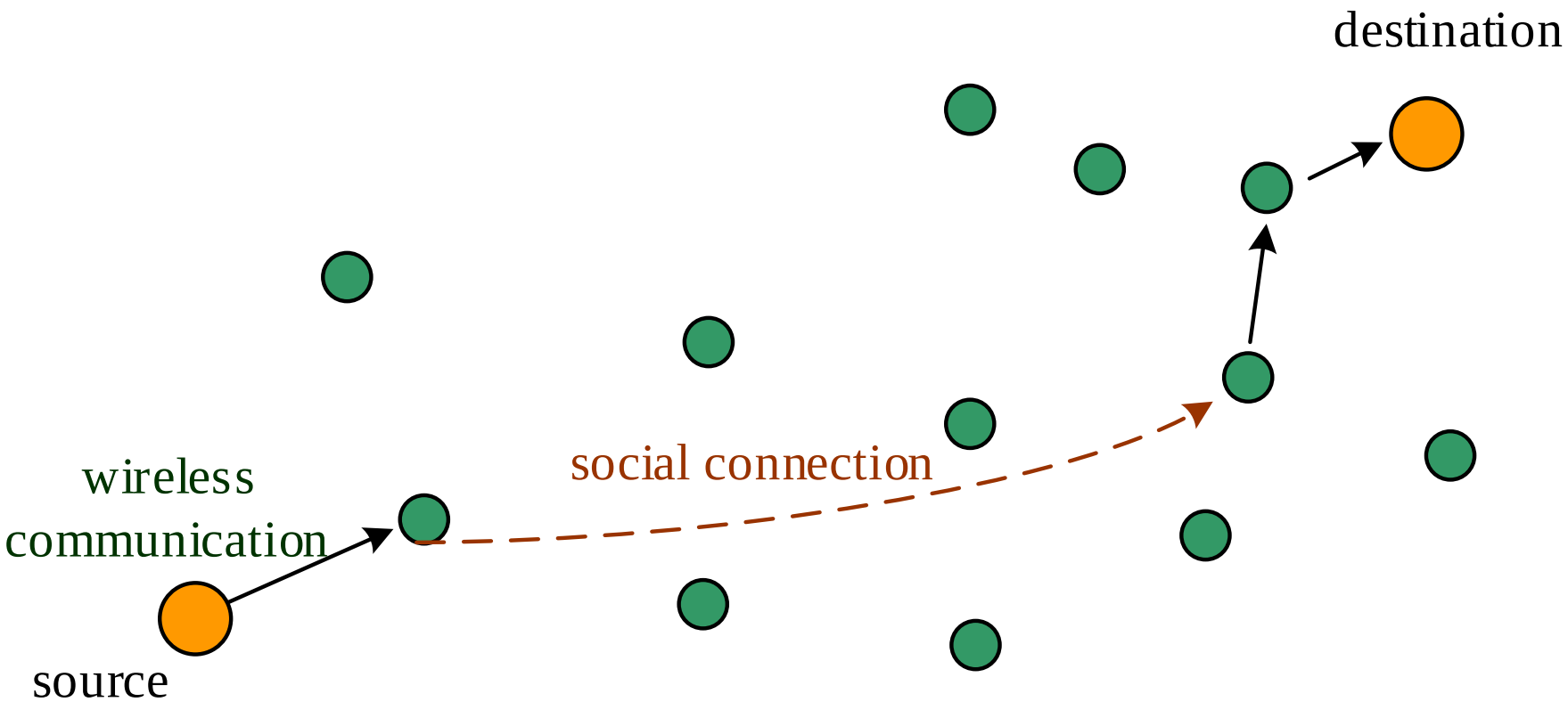
Fading Profiles:
Rayleigh, Rician, Pure Doppler,
Freq/Phase Shift, Log-normal Fading

Interference Generator:
Independent per channel

Control Panel for the Testbed

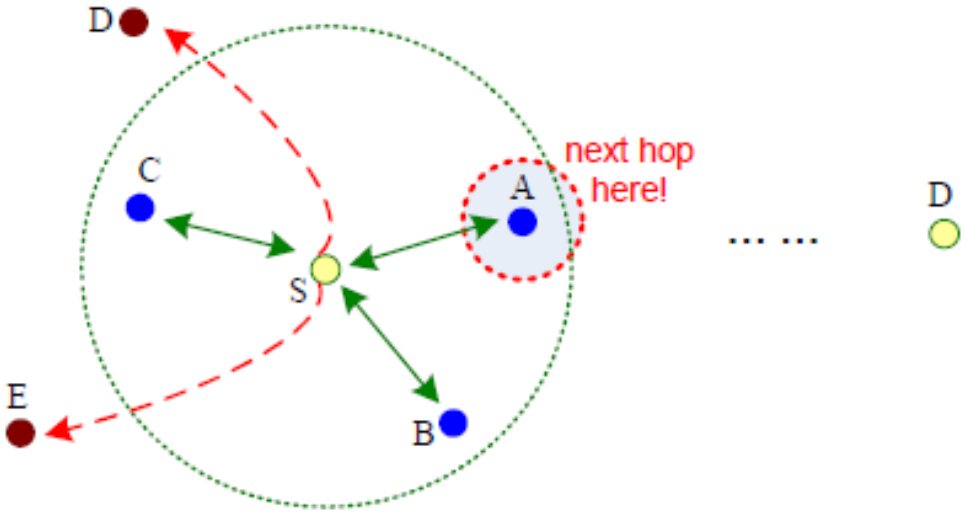


How to send a message: example



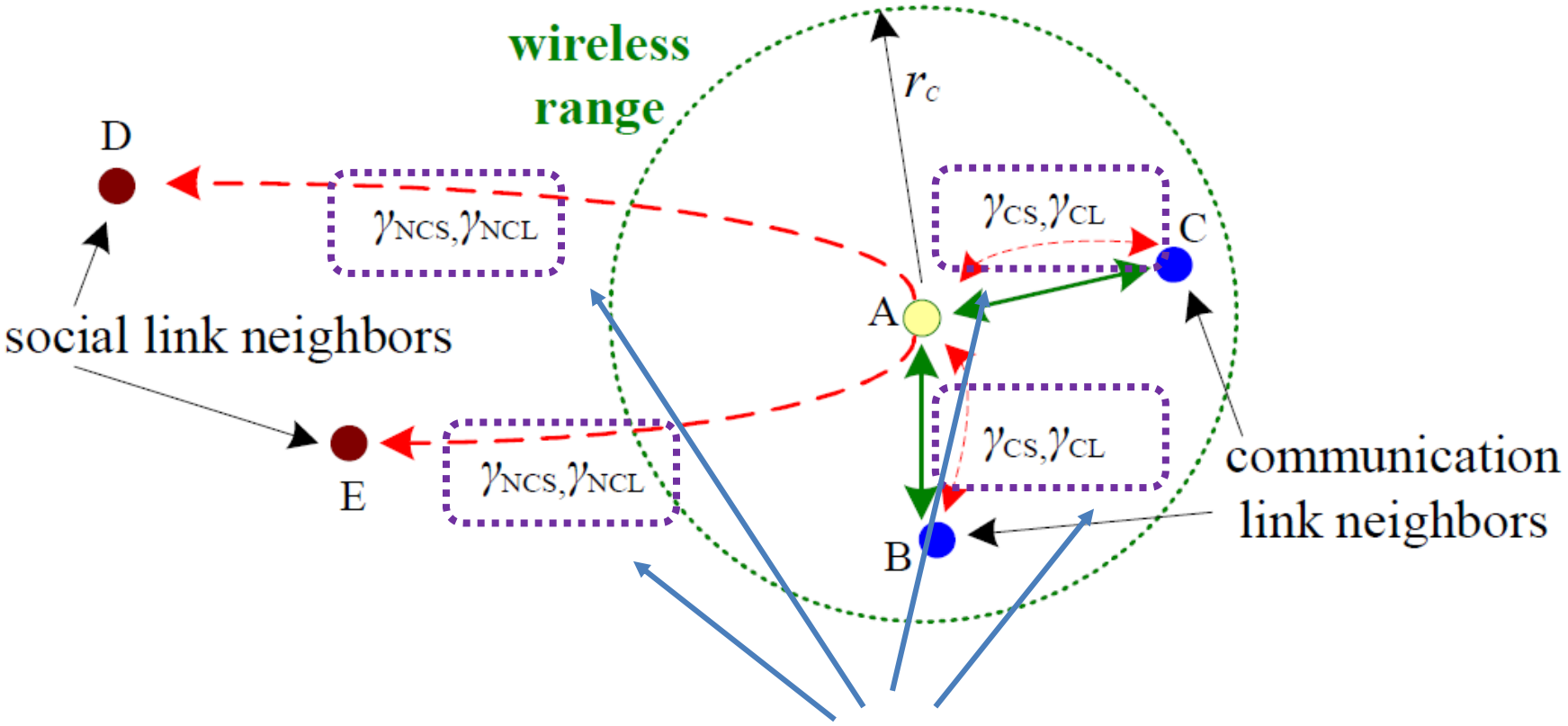
Greedy Routing

- **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.**



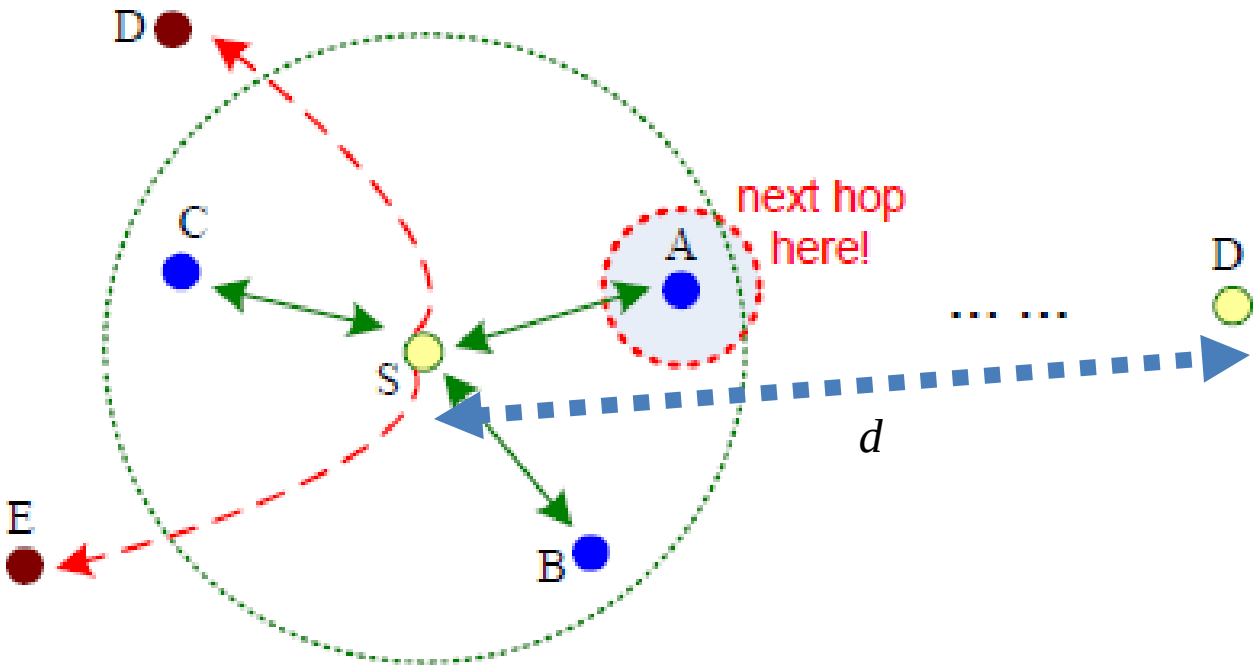
Coupling between social & communication links

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



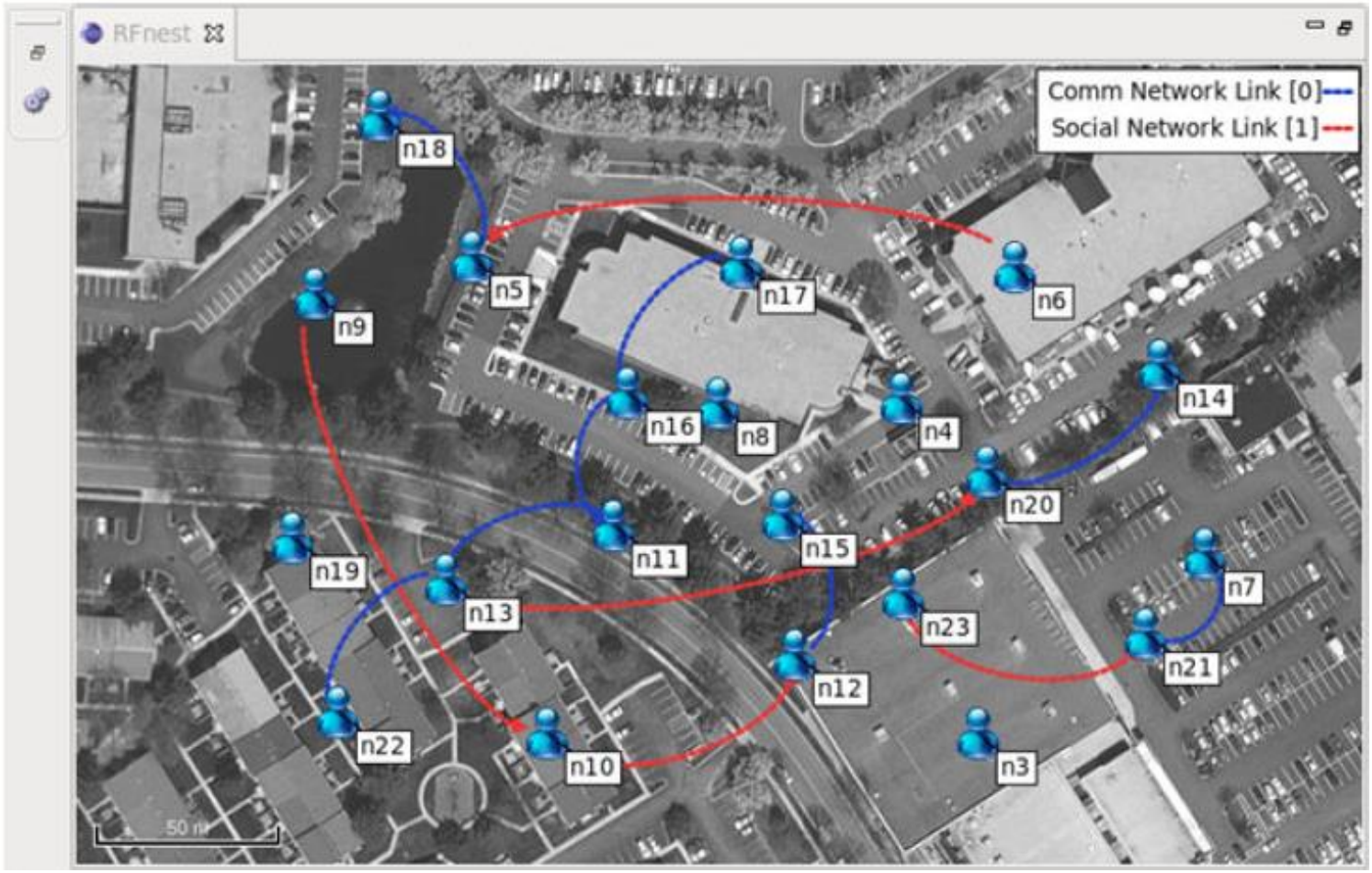
Distance between source and destination

- d – the distance

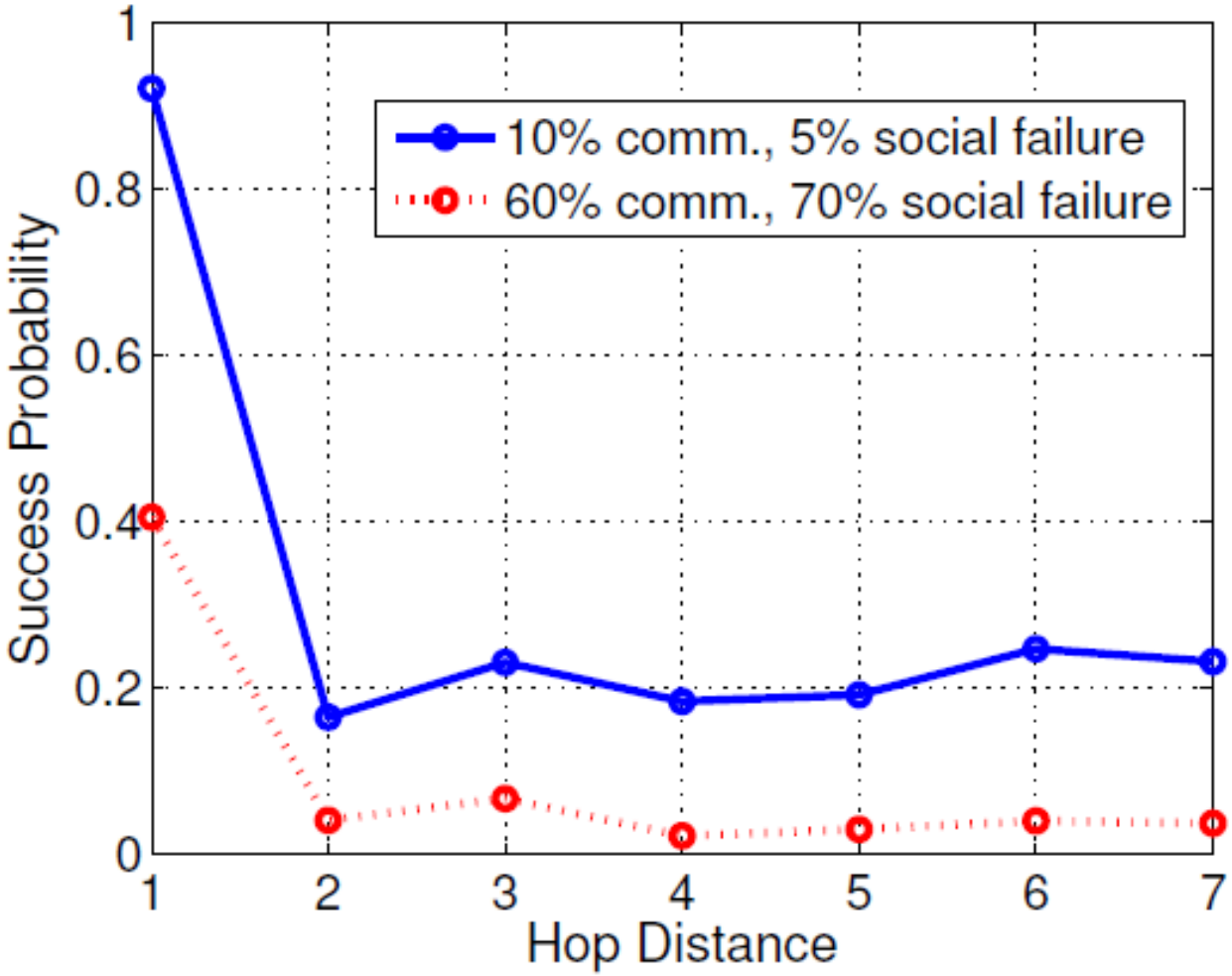


Overall a very challenging question to get delay and delivery ratio!
Get an analytical solution? Mission impossible!

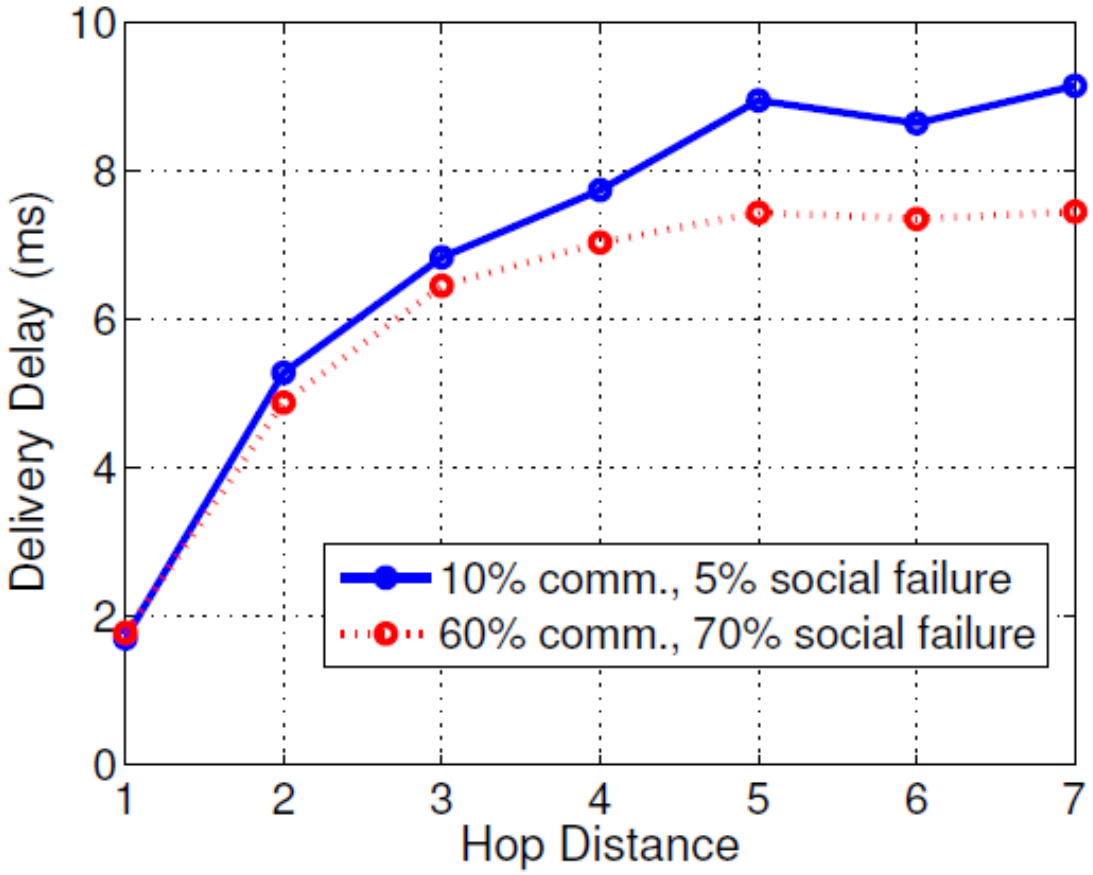
Visualization



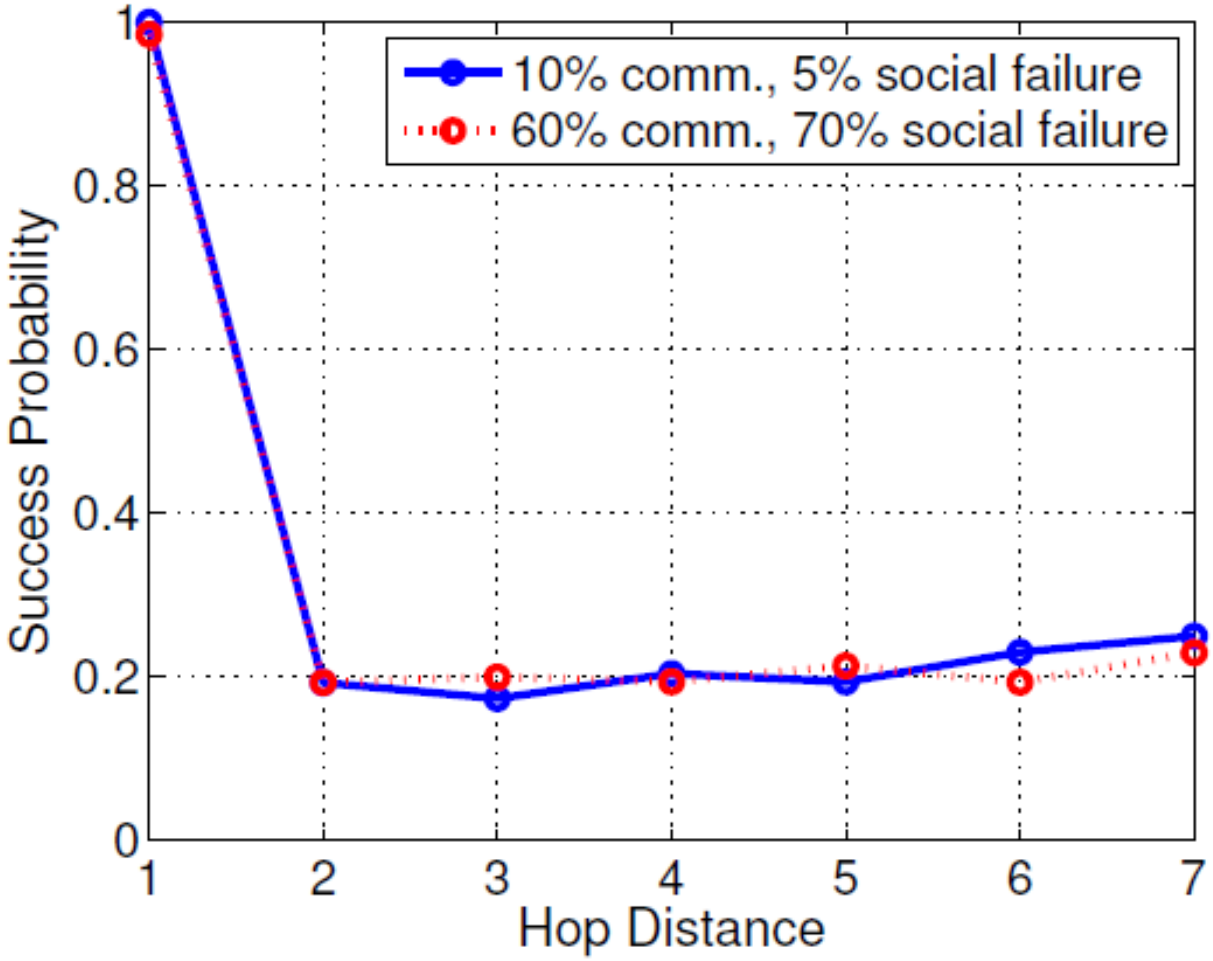
Experiments: Success Probability



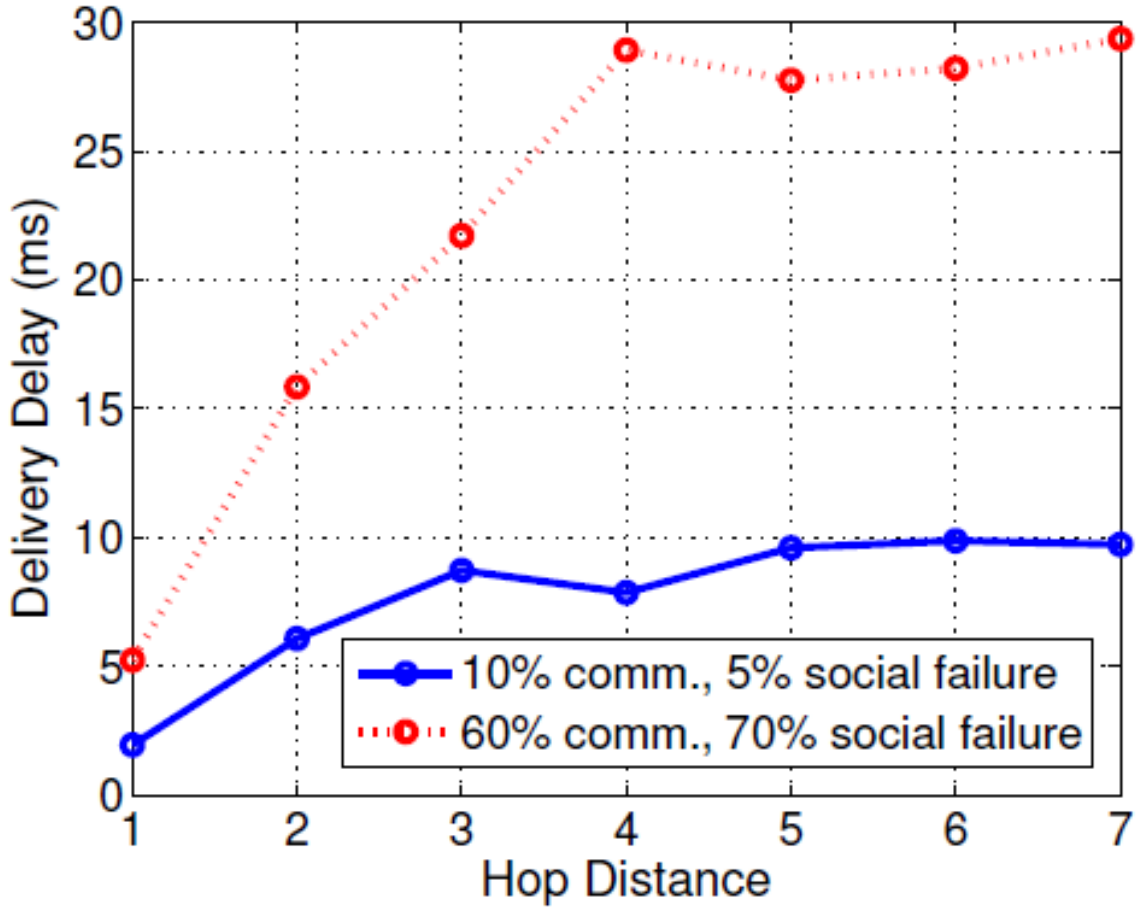
Experiments: Delivery Delay



Persistent Transmission: Success Probability



Persistent Transmission: Delivery Delay



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.**