Overview

Interested in what role human mobility and proximity plays in opportunistic networking.

What can we find out just by moving around and seeing other nodes (no global knowledge, apart from the assumption that *some* nodes will co-operate.)

We want to know how much information a nodes can possibly know about the state of the network, by only having access to information through interactions with other nodes.

We also want to be able to predict when we are likely to meet another node based on knowledge of location and proximity. If we can do this, then we can design opportunistic networking protocols based around it.

Hypothesis:

- Human mobility patterns are predictable;
- Human proximity patterns are predictable;
- Knowledge of proximity and location makes opportunistic routing more efficient than proximity alone.
- Proximity and Mobility can be used independantly to achieve the same efficiency in oppotunistic networking.
- Mobility or Proximity can be discounted when planning opportunistic networking algorithms.
- Any given node will only need to communicate with with other nodes that they know (friends), or want to know (friends of friends).

Local Metrics

The interesting part is discovering what peoples habits are. The engineering bit is making use of this knowledge for some purpose.

- Periodicity
    - The notion of the amount of time between regularly occurring proximity events
    - correlation between the number of proximity events (i.e. new sightings of a device) and time

- Maintain record of
    - Proximity - who I saw and at what time
    - Location - where I went and at what time

- Sharing vector clocks based on proximity and location, with other nodes, allows us to compute metrics for:
    - Determine out of date nodes
        - ones we havent seen (in terms of location and proximity) for a long time
    - Range of nodes
        - A nodes range is based on the number of hops away

            - Range = hops between self and node W
            - ?can be determined by sharing route knowledge (DSDV? / AODV)
        - information latency / update
            - How often a node is seen and the clock is updated
            - How much more information a node gives about known nodes
                - Is this a good indicator for determining the importance of that node (in the case of other nodes)?
                - When difference in time between the last known information about a node and the new information is high, then the node giving the information is likely to have access to nodes that other contacts do not see often
        - Ball of Radius can determine a nodes membership
            - Ball of radius is bounded by a length of time, nodes for which updated information is available within this time are within the ball of radius
- My ideas about location
    - Different types of location
        - Common locations
        - Home/Work locations
        - Transitory locations
        - Hub locations
        - Unkown locations
        - Irrelavent
    - Determining location
        - concatenation of common location grids..... ?
        - prediction of location

Plan/Experiment:

Categorize and define distinct location types and sub-types

- Public
- Private
- Home
- Work
- Transitory
- Hubs
- Irrelavent
- Unknown

Re-create experiments by Barabasi etc.:

- Vector Clocks - determine possible information paths based on proximity and also based on location (e.g. as drop points)
    - can use small dataset if needed
- Periodicity - find the periodicity in a dataset

Explore the correlation between proximity/location

- Is proximity just a different form of location

Test concept:

- Write code to run over the basic dataset
    - Try to predict location based on - Limits of human predictability Paper by Barabasi

        - Calculate Periodicity on the fly - using own traces from N95?
        - Test the deliverability based on the networks formed by location and proximity
    - See how much knowledge is built up over the interaction between nodes over the time of the dataset
        - i.e. keep vector clocks of proximity and location
    - Visualise the states of the nodes over time, see what really happens (just the vector clocks) (ODCSSS Summer project?)

Simulator:

- Provide an interface to metrics for each node
- test probablistic routing algorithms (e.g. CAR) with different metrics based on
- Test our routing algorithm

Possible Test Datasets:

- Quick and dirty dataset from Gowalla users
- Cabspotting (for comparison)

Outputs

- routing algorithm based on proximity and location
- Statistical analysis of the use of vector clocks for network knowledge

Application

Application: So nodes dont need infrastructure to communicate.
Application: Data mules for sensor data
Application: Powered sensor nodes carried by humans (animals?)
Why: Because we can, and because its an alternative that can support existing networks - datamules for data intensive applications - do your bit - help transmit sensor data!
Why: Because sometimes (in some countries) infrastructure is unrealiable (e.g. Lahore where umer is there are frequent power outages)

Contributions

- Definintion of important types of location
- Algorithm to define areas of any size based on visitation patterns and importance to the swarm
- Combination of techniques (Vector clocks, periodicity hunting, location prediction, proximity prediction) to see network structure without global knowledge.
- Completely decentralised and infrastructureless routing algorithm for communication between mobile phones