Interpreting Wireless Trace Data in Delay Tolerant Networks

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Introduction

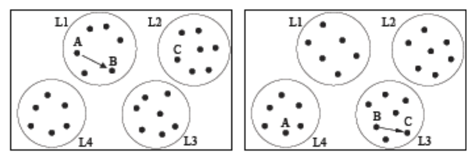
The study of Delay Tolerant Networks (DTNs) has become an increasingly important area to networking researchers. These networks are becoming more and more common in various applications around the world, and even in future space exploration. By investigating these networks, we can devise schemes that allow for better message sending and delivery, while decreasing the energy needed to send these messages. Not only is it important to understand the structure of these evolving networks, but it is also important to be able to visualize them as well, so that patterns and recurring traits can be found.

Background

Delay Tolerant Networks are mobile ad-hoc networks that are made up of nodes that are constantly moving or unable to maintain a constant connection. Because of this, there may often not be a continuous, end-to-end path between a source and destination node, as there always is in a standard network. Figure 1 shows a simple example of a DTN. To solve this problem, many creative approaches have been devised in order to try and get a message from a source node to a particular destination.

These methods all revolve around the idea that any node in the network can store and then forward a message, and therefore, eventually pass the message to its destination. However, these methods vary in complexity, as the simplest ones are very expensive in terms of the resources needed.

Because these networks are often formed in social situations, such as a fleet of campus buses or students at a conference, patterns begin to develop over time between certain nodes. Based on these patterns, more efficient routing methods can be devised for a particular network.



(a) Network Topology at Time t (b) Network Topology at Time $t+\Delta t$

Figure 1: Simple diagram of a DTN [1]

Previous research in the Networking Research Lab has concentrated on static models of wireless networks and what efficient routing algorithms can be developed for them. However, since these are static models, they do not accurately reflect a DTN structure, whose node topology changes over time as nodes move, meaning connections and paths that existed at one point may not exist later.

Research

My area of research centered on creating a set of functions that would read in wireless trace data about various DTN's from the CRAWDAD datasets [2]. These trace sets contain position and/or contact information about nodes in a wireless network. This information can then be used to recreate the network, test routing algorithms, or gather various other pieces of information.

Because the trace data found on the CRAWDAD website come in many different formats, my job was to not only find usable traces and read in the data from them, but to also create a uniform data structure that could be used to easily manipulate the data as well.

Home page for CRAWDAD website [2]

Furthermore, I created some simple functions to gather information about the data in order to test what could be done with it. These included functions that would print basic info about the network and its nodes, or compare the number of connections between two nodes during the day. Figure 2 shows an example.

Conclusions

Because of the nature of the project, there were no concrete conclusions to be reached. However, I did successfully create programs for 12 different data traces from the CRAWDAD website that store the traces into the data structure, and can then be used as desired.

In addition, I gained valuable experience not only with programming in C, but with programming principles in general, such as debugging my code. Furthermore, I learned a great deal about wireless networks and Delay Tolerant Networks and how they are becoming such an important part of our world.

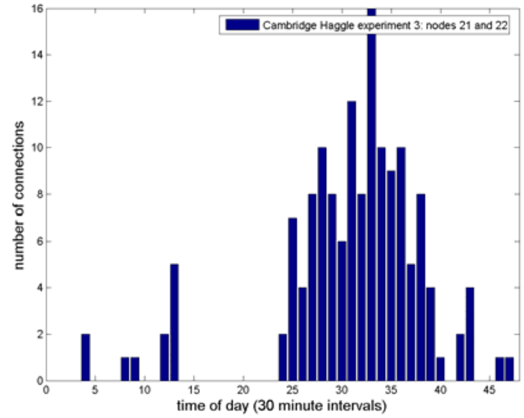


Figure 2: bar graph created using my program and MATLAB, showing the number of connections between two nodes over 4 days, displaying what time of the day they occur. The peak reflects a strong social contact pattern.

Future Work

Currently, my programs are to be the foundation of more research into DTNs and how they function. We would like to first devise an efficient method for visualizing these dynamic networks, since the normal means of visualizing static networks cannot be used. Furthermore, we would like to investigate patterns and look into ways to make these networks have efficient routing algorithms.

From this, it may be possible to extend the methods used to look into other networks so that similar routing algorithms can be developed on them

References

[1] I. Cardei, J. Wu, and Q. Yuan. Predict and Relay: An Efficient Routing in Delay Tolerant Networks. In *Proceedings of MobiHoc*, 2009.

[2] Community Resource for Archiving Wireless Data At Dartmouth (CRAWDAD). http://crawdad.cs.dartmouth.edu/