A Comparison of Wireless Network Protocols from a Simulation Perspective

by Robert Bathmann

A Proposal Submitted to the Honors Council

For Honors in Computer Science

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Thesis Statement

This thesis will compare the specifications of several wireless network protocols. It will also involve the implementation of an additional wireless protocol to add to an existing network simulation tool.

This is a great start. At the end of the first paragraph below, I would put a sentence that connects it with the second paragraph. Something to the effect that "all those wireless networks had to be studied in some cost-effective way before they became mainstream technology."

Background

Wireless networking has increased the level of mobility, convenience, and productivity of computers and technology. It has allowed laptops to connect to the Internet from anywhere in the vicinity of an access point or other computer. Wireless headsets can now communicate with cell phones to provide a safer way to drive. Additionally, a network of low-powered devices can be used to collect data where wires would make it difficult or impossible.

Directly studying wireless networks is a challenging task for two reasons. First, the conditions surrounding the experiment can never be fully controlled and therefore not repeatable. Second, it is difficult to manage (and pay for) a large-scale experiment with many network nodes. A high-performance computer simulation allows for fully controllable experiments with repeatable results. Since networking hardware is not required, simulations can be conducted at low cost and still yield usable results. (Liu, et al. 2001)

many human-operated hardware devices?

...uses "models" of network protocols and...

a model is... captures the essence of the system...

Three main metrics are used to study wireless networks. First, the packet delivery ratio is used to indicate success rate of transmitting data. It is the percentage of packets received relative to the number of packets sent. Second, the time delay between sending and receiving a packet represents the network latency. A small latency is desired for most network applications. Last,

the

ambiguity

the amount of overhead traffic needed for network analysis and routing is used to indicate the efficiency of the network.

This is where the discussion of the OSI seven-layer model will be. I will use the Computer Networks book as a source.

Wireless networks can be split up into two classifications: WLAN and WPAN. Wireless Local Area Networks often provide mobile access to wired network resources. They offer high-rate data transfer over an average distance of about 300 ft. On the other hand, Wireless Personal Area Networks provide networking on short distances of about 30 ft and at lower data rates. Since they are limited in bandwidth and range, their power consumption and cost is minimized (Gutierreze, Barrett and Callaway 2007, 4-5).

Wi-Fi

Wi-Fi was created to eliminate the main disadvantages of local area networks: wires. Although Ethernet was a success, it required special networking cables to be installed from computer to computer. A wireless implementation of Ethernet would solve this problem. As a result, the 802.11 Wi-Fi standard was created (Cooklev 2004, 45).

Different physical layers exist for 802.11 wireless networking. Each physical layer will have unique power, range, and bandwidth specifications. For example, 802.11b has a maximum throughput of 11 megabits per second and has a range between 150-1000ft depending on environmental condition with a frequency of 2.4GHz. The bandwidth was increased to 54 megabits per second with 802.11g, which uses a different physical layer and a modified MAC layer to ensure backwards compatibility with 802.11b (Cooklev 2004, 98-116).

Bluetooth

The 802.15.1 specification defines Bluetooth, a WPAN networking standard. However, Bluetooth differs from other standards in this proposal in that it describes all seven layers of the networking stack and their boundaries are not clearly defined (Cooklev 2004, 136). Additionally, not all layers are used during data transfer. For instance, voice applications have a direct link to the bottom-most baseband and radio layers for improved quality of service (Miller and Bisdikian 2001, 61-62).

Zigbee and WSNs

Also a Wireless Personal Area Network standard, 802.15.4 describes the Zigbee standard. This protocol is intended for use with extremely low-powered devices, short transmission distances up to about 30 ft, and low data rates up to about 250 kilobits per second. The primary application of Zigbee is within Wireless Sensor Networks (WSNs). WSNs are used to decrease the cost of installing sensors, avoid the problems caused with cable connections, and decrease the complexity of the network (Gutierreze, Barrett and Callaway 2007, 4-7).

Since the specific applications of Zigbee and WSNs are probably less familiar than Wi-Fi and Bluetooth, it is helpful to illustrate with examples. A sensor network for home automation could be deployed to monitor temperature readings in different rooms and adjust the thermostat accordingly. Wireless smoke detectors and burglar intrusion sensors could interact with a home security system. A WSN could also be used to increase the efficiency of farming by creating a self-organizing network to take soil readings and other statistics across large fields. Additionally, small wireless gadgets such as remote controls and toys can take advantage of the low cost and power demands of Zigbee (Gutierreze, Barrett and Callaway 2007, 13-21).

Significance

Studying wireless networks is vital as they are becoming more widespread. Simulation can yield relevant information on the scalability of wireless networks and find performance hazards corresponding to the three main metrics previously discussed. Simulation can also uncover different security attacks that might be possible on wireless networks.

A comparison of wireless network protocols is useful to gauge the possibility of observing similar outcomes on different protocols. For instance, it is helpful to know if attacks on Wi-Fi networks may also work on a Zigbee networks. Furthermore, the simulation implementation of the Zigbee protocol would definitively answer the question.

just the comparison on its own is already a worthwhile contribution

Professor Perrone currently uses and develops the Simulator for Wireless Ad Hoc Networks (SWAN). However, it currently can only simulate 802.11b wireless networks and limits the scope of his research. A comparison of other wireless network protocols and the implementation of an additional protocol in SWAN would broaden his research impact.

Timeline and Methodology

The first component of my thesis will be a comparison of the three wireless network protocols. Both technical books and the official IEEE standards on the protocols will serve as the main resources for my research. They ~~should~~ specify all the details about the medium access control and physical layers that is needed for the comparison. I expect to be familiar with this literature before the beginning of the Spring semester in order to begin my thesis.

in order to start the "formal writing"

The second component is the implementation of an additional wireless network protocol for SWAN. Since the network stack for Bluetooth is not suited well for use within the SWAN framework, Zigbee will be attempted to be implemented. At this point, it is unclear exactly how

model of

much time and effort that will take. Implementations are available for other network simulators but it is not known how easy they can be will be to port to SWAN. Therefore, I will at least begin to work on the implementation of the Zigbee standard. As I begin the detailed research into the network protocols for the first component, the feasibility and the time required will become clearer.

Conclusion

This is where the conclusion will go.

Literature review and written comparison - second Monday of the Spring semester

Implementation / porting work - up until four weeks from defense date: April 1st

Turn in to committe: April 15th
Defense date: April 22nd

Final date for submission May 4th

Works Cited

Cooklev, Todor. *Wireless Communication Standards.* New York: IEE Press, 2004.

Gutierreze, Jose A., Raymond Jr. L Barrett, and Edgar Jr. H Callaway. *Low-Rate Wireless Personal Area Networks.* New York: IEEE Press, 2007.

Liu, Jason, L. Felipe Perrone, David M. Nicol, Chip Elliott, and David Pearson. "Simulation Modeling of Large-Scale Ad-hoc Sensor Networks." 2001.

Miller, Brent A., and Chatschik Bisdikian. *Bluetooth Revealed.* Upper Saddle River, NJ: Prentice Hall, 2001.

Article: Simulation Modeling of Large-Scale Ad-hoc Sensor Networks, Jason Liu, L. Felipe Perrone, David M. Nicol, Chip Elliott, and David Pearson. European Simulation Interoperability Workshop 2001. London, England.