

**Assignment 3****40 points****Evaluating the Performance of a WLAN in Harrington Gym****Due: Monday, December 3, 2007 at 10 a.m.****Introduction**

Assume the following scenario:

Your programming team has been hired by FEMA (the Federal Emergency Management Agency) as a consultant to evaluate Wireless Local Area Networks (WLANs) consisting of one or two access point (APs) and up to 50 wireless nodes made up of approximately 80% PC's and laptops and 20% PDAs or cell phones equipped for Internet access.

After Hurricanes Katrina and Rita, FEMA wants to improve its preparedness at providing for disaster evacuees who might be housed temporarily for up to two months in small high school gymnasiums. In addition to providing food and shelter, FEMA desires to deploy instantly WLANs at these locations that would connect to the Internet via a single broadband cable or FiOS connection already available at the high schools.

FEMA wishes to provide the displaced families with the ability to access several specially designed 'disaster evacuation' application tools [see program 4] plus a few standard Internet services to improve the morale of the evacuees. Particular applications to consider in your study include: access to Internet games, instant messaging, downloading of government forms that need to be filled out and returned electronically, streaming movies (especially government assistance films) from a FEMA controlled multimedia server, streaming of cartoons for small children, and the ability to talk to relatives over a VOIP application.

FEMA has hired your team to conduct a preliminary prototype WLAN measurement study in WPI's Harrington Gym where you would be free to select one off-the-shelf AP that supports 802.11g or 802.11n, purchase 10 wireless nodes of various types and one wireless sniffer. Using the specific layout of Harrington Gym, your assignment is to provide a design document that provides a detailed plan of exactly which measurements you would conduct that includes specifics concerning the equipment that your team recommends purchasing for the prototype measurement and the use of publicly available measurement tools and traffic generators. (Assume for this discussion that you will be provided with free access to all the wireless measurement tools developed by the WPI CS Department Wireless Streaming Multimedia Lab (WSML) (see <http://perform.wpi.edu/wsml/>) and discussed in the [Li et al.] and the [Gretarsson et al.] papers.)

**Design Assignment**

Each team is to submit a Design Report (not to exceed 12 pages) providing the details for your prototype WLAN measurement tests to be conducted in Harrington Gym. Specific emphasis in your final grade will be placed on your specific justification for how the performance results derived from your prototype measurement study would be used by FEMA to determine: the limitations of using a single AP versus two

coordinated APs, the number of wireless clients that can be reasonably supported by one AP, location considerations for wireless client nodes and whether some of the Internet applications proposed by FEMA need to be restricted or dropped from the list of applications to support.

## Requirements List

Your measurement design report must include:

1. a recommended list of equipment to purchase for the prototype measurement that includes AP and client nodes [**Note well – The TA will provide you with documentation for a “home-brew” wireless sniffer that the WSML will provide for your experiments in Harrington Gym**].
2. an itemized list of measurement experiments that your team proposes to conduct. This list must have a minimum of five distinct experiments and may have more but assume WPI will only give your team total access to Harrington Gym for two days between Christmas and New Years Day 2007. Discuss what tools will be used to generate traffic for the proposed experiments.
3. An itemized list of all network performance metrics that you propose to measure. Group these metrics by which layer in the protocol stack the measurement tool will operate. Discuss which specific tools will be employed to measure each individual performance metric. Decide which metrics are the most important for this situation.
4. A detailed discussion of your **exact** experimental methodology that includes such details: applications to run, the number of repeated experiments, duration of experiments, schedule of measurements over a 48 hour period, location and movement of the APs and the client nodes during experiments, the number of people needed to conduct the experiments and preliminary thoughts on software tools that might need to be developed to automate the experiments and provide an organized scheme for storage of all experimental results.
5. A discussion of tools to be used to provide performance graphs to present to FEMA. Propose five distinct graphs that you would produce from your experiments with a brief discussion of the value of each graph to the prototype study objectives.
6. A preliminary list of hypotheses that you expect to test during your prototype measurements in Alumni Gym.

When making your choices with respect to your design report, keep in mind the robustness of your design such that your procedures could easily be deployed in different configurations that might include temporary cubicle barriers for families and the ability to compare the performance of all the top recommended access points within the framework of your experimental procedures.

## Questions

These questions are designed to help your team think about some of the details in your proposed design. Please provide specific answers to these questions as part of your final design. You are free to integrate your answers within the prose of the design report. However, to facilitate the itemized grading of this assignment, please provide an Appendix or another mechanism that clearly indicates where the grader will find your response to each of these questions.

1a. Consider an 802.11g AP with 54M bps connecting speed. If you were to stream a one-hour video of the Survivor television show at 600kbps through this AP, in principle, how many concurrent video streams can the AP support?

1b. Which experiment in your measurement study can be used to verify this answer?

2a. Explain why it is important to measure at multiple layers in the protocol stack.

2b. What are the tradeoffs between using a wireless sniffer to gather data on wireless frames versus putting measurement hooks in the AP and the wireless nodes?

2c. Name the specific types of wireless frames that you expect to capture from the wireless sniffer. What type of interference do you expect to encounter and how do the measurements get more difficult when you are dealing with two cooperating APs?

3. Discuss what experimental procedures you will employ to reduce the number of independent variables and sources of interference that your measurements may encounter.

4. Explain the differences in the impact on performance of :

- a video frame being dropped at a wireless client due to jitter.
- a TCP packet being lost or dropped.
- a UDP packet being lost or dropped.
- a 802.11g frame suffering five retries.
- a hidden terminal from somewhere else on WPI's campus

5a. Explain RTS and CTS in 802.11g?

5b. How can RTS/CTS improve or worsen performance?

5c. What experiments could your team run to help decide whether or not RTS/CTS should be enabled?

6a. Postulate on what are the *worst* locations for placing wireless nodes in Harrington Gym.

6b. If you were FEMA, what are the *best* locations in Harrington Gym for putting bunk beds for two children with respect to human comfort? How does this impact the design of your measurement tests?

6c. Assume you must predict best and worst case performance for two concurrently running wireless clients located at the 6a and 6b locations. How would you decide on the best place to locate one or two APs in the scenario where it **ONLY** served these two client machines?

7. Assume that your research shows a generic VOIP application that is compressed using an 8kbps codec. Given that conversations usually required a delay less than 100ms, explain what you need to measure and how you would measure it to insure that Quality of Service is high when a high number of concurrent VOIP applications are running over the WLAN in Harrington Gym.

## References

[Akella et al.] A. Akella, G. Judd, S. Seshan and P. Steenkiste, “Self-Management in Chaotic Wireless Deployments”, *The 11th International Conference on Mobile Computing and Networking (MobiCom05)*, Cologne, Germany, September 2005, pp. 185-199.

[Gretarsson et al.] J. Gretarsson, F. Li, M. Li, A. Samant, H. Wu, M.L. Claypool, and R.E. Kinicki, “Performance Analysis of the Intertwined Effects between Network Layers for 802.11g Transmissions”, *The First ACM Workshop on Wireless Multimedia Networking and Performance Modeling (WMuNeP05)*, Montreal, Canada, October, 2005.

[Ihmig and Steenkiste] M. Ihmig and P. Steenkiste, “Distributed Dynamic Channel Selection in Chaotic Wireless Networks”, *The 13<sup>th</sup> European Wireless Conference*, Paris, April 2007.

[Li et al.] F. Li, J. Chung, M. Li, H. Wu, M.L. Claypool, and R.E. Kinicki, “Application, Network and Link Layer Measurements of Streaming Video over a Wireless Campus Network”, *The Sixth Passive and Active Measurement Workshop (PAM05)*, Boston, April 2005.

[Yarvis et al.] M. Yarvis, K. Papagiannaki and W.S. Conner, “Characteristics of 802.11 Wireless Networks in the Home”, *The First Workshop on Wireless Network Measurements (WinMee05)*, Riva del Garda, Italy, April 2005.