WLAN Measurement Report {Modified 14 April 2011} 40 points

Evaluating the Performance of a WLAN in Harrington Gym
Due: Tuesday, April 19, 2011 at 8 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 three access point (APs) and up to 45 wireless nodes made up of approximately 75% PC's and laptops and 25% PDAs, cell phones or smart 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 quickly deploy 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 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 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 such as Skype.

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 three identical off-the-shelf AP's that support 802.11g or 802.11n, purchase 15 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 Mulitmedia 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 30 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 be FEMA to determine: the limitations of using one AP versus two or three 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 preliminary list of hypotheses that you expect to test during your prototype measurements in Harrington Gym.

2. 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].**

3. An itemized list of measurement experiments that your team proposes to conduct. This list must have a minimum of four distinct experiments and may have more but assume WPI will give your team total access to Harrington Gym for only three days between the last day of the D11 term and the May graduation. Discuss what tools will be used to generate traffic for the proposed experiments.

4. 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.

5. A detailed discussion of your **exact** experimental methodology that includes such details: applications to run, the number of times to repeat each experiment, duration of experiments, schedule of measurements over a 72 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.

6. Propose five distinct graph layouts that you would produce from your experiments with a brief discussion of the value of each graph to the prototype study objectives.

When making your choices with respect to your design report, keep in mind the robustness of your design such that your procedures could easily 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 roadmap mechanism that clearly indicates where the grader will find your specific response to each of these questions.

1a. Consider an 802.11n AP with 124 Mbps 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? Explain why the design of the DCF restricts the actual capacity to significantly lower than 124 Mbps.

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

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

2c. Name the specific types of wireless frames that you expect to capture in your study. 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. a video frame being dropped at a wireless client due to jitter.
   b. a TCP packet being lost or dropped.
   c. a UDP packet being lost or dropped.
   d. a 802.11n frame suffering five retries.
   e. hidden terminals from somewhere else on WPI's campus.

5 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 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 three 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 150ms, explain what you need to measure and how you would measure it to insure that Quality of Service is high when 35 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 13th 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.