Real-time streaming over an IEEE 802.11b [1] based wireless LAN test bed

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Abstract

Wireless LAN systems based on IEEE 802.11 have become a path-breaking innovation and have revolutionized the home, educational establishments and office network markets [2]. We have attempted to analyze real-time video streaming issues over a wireless LAN test bed based on such a mature technology, in our paper. The creation of this test bed is an ongoing effort at the Electrical Engineering & Computer Engineering (EECE) Department at the University of New Mexico, Albuquerque, New Mexico, which shall serve to promote future research and development, under the aegis of Ibero American Science and Technology Education Consortium (ISTEC) [3].

Keywords

Site survey, IEEE *802.11b*, Line-of-sight, Wireless video.

1. Introduction

This paper analyzes and reports the various technical aspects of real time video streaming over a wireless network, in the *EECE* Department, University of New Mexico (UNM), Albuquerque, NM. The basis of such a test bed is an *IEEE 802.11b* based wireless LAN system, which links to the backbone wired Ethernet [4] network of the department. Such a secure platform is intended to provide access to a series of online classroom lectures as well as knowledge repositories and research spaces to all of the *ISTEC's* 120 member universities.

The plan of action for the whole scheme is a thorough survey of the proposed area of implementation, comprising of a : Site survey or generation of an RF map of the building, wireless camera signaling survey and finally , the real-time, wireless video streaming.

2. Site Survey

The first step in the *RF* survey was positioning the wireless access points to access the network. In order to have an idea of possible locations and power levels of each access point in a building, a site survey was conducted. We employed a *Cisco Aironet® 350* series Access Point , *Cisco Aironet® 350* Series Client Adapter Cards and a *D-Link® DCS 1000W 802.11b* VGA quality Wireless internet Camera , for the surveys. The measurements were based on the placement of a single access point, radiating anywhere between 5 –100 mW of power, at a suitable location, such that it would be advantageous to all three floors of the *EECE* building. This was done to economize the number of access points that shall be totally used in the end. The analyses were based upon the three performance parameters, namely:

1. Signal Quality,.
2. Received Signal Power in absolute percentage and
3. *Signal to Noise Ratio* (SNR) in dB.

Figures 1.(a) and (b), 2.(a) and (b) and 3.(a) and (b) give an idea of the signal strength variations in dB across each of the three floors respectively and the dependence of the above mentioned parameters on the distance of the moving wireless PC card attached to a laptop, from the
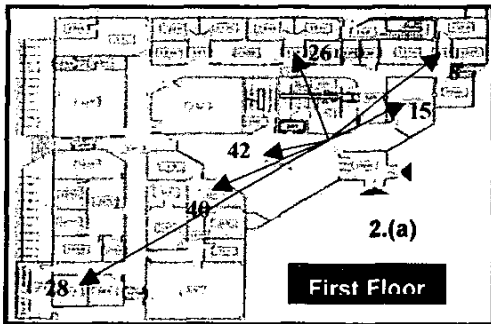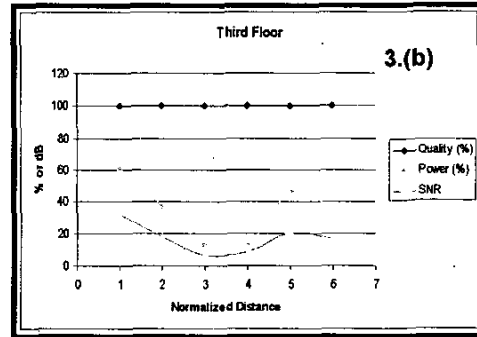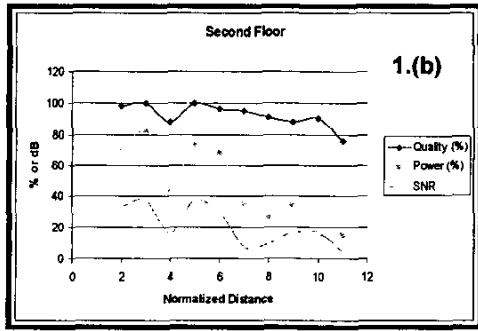

1.(a)
Second Floor
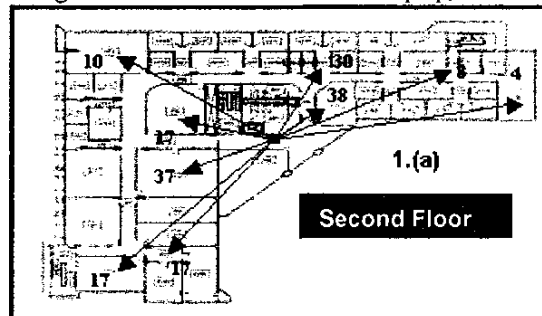
Figure 1.(a) and (b), 2.(a) and (b), 3.(a) and (b) : Coverage map and variation of the performance parameters with respect to the Normalized Distance in meters for the second, first and third floors, respectively.

access point. From these data, attenuation due to distance can be easily observed, although there are slight fluctuations in the values. Long distances between the access point and the *Ethernet* card caused the signal to degrade. Also the fact that, a Line-of-sight between the access point and the wireless PC card always gives the best signal quality, is exemplified by the values obtained. Because of this, the location of the access point forms an important part of the design of a wireless network in a building.
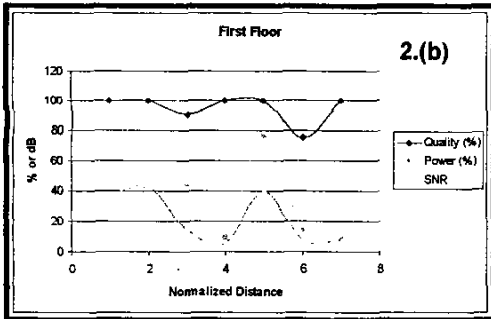
The observed swings in the recorded parameters can be explained by the material between the access point and the user, which has an impact on the attenuation of the signal. The concrete slabs that make up the floors of the building have a much greater impact on the received signal that say the drywall that separates the rooms on each floor.
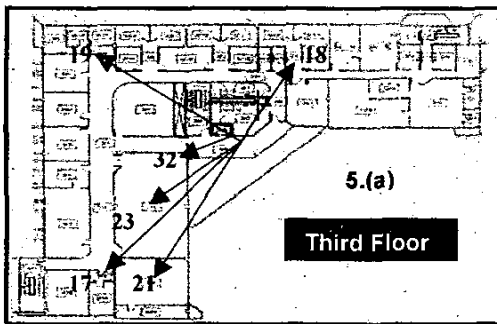
Location	Quality (%)	Power (%)	Grade	SNR
108	100	19	P	11
137	100	15	P	6
123	no	signal	received	associated
131	no	signal	received	associated
Atrium	100	38	F	19
237	100	81	E	44
232	100	58	G	30
215	100	19	P	7
210	100	36	F	15
Balcony	100	38	F	18

Table 1 : A survey result over the three floors of the building.

As shown in Table 1, a reading taken of an access point at 20 mW on the 2nd floor approximately 10 m away in a room on the same floor gave a result of 58% power and a rating of "Good" while a measurement directly beneath that same access point approximately 2 m away on the 1st floor resulted in a signal power of 19% and a rating of "Poor".

We discovered in the survey that it is not practical to have one access point at 100 mW radiate the entire building. Much stronger signals were attained outside the building than in some parts of the interior. One access point, with under 10 mW power levels, in the center of the building still does not generate enough power to reach the far corners of the building, as well as some of the rooms. But power levels of around 20-30 mW were suited to the topography of the building and provided ideal and satisfactory coverage in most parts of the structure.

2.1 Wireless Camera Survey

The wireless camera survey was conducted, with the help of a *D-Link® DCS 1000W* wireless internet camera, attached to the access point via its *MAC* and *IP* address. The image from the camera was obtained from a computer screen by simply typing in the IP address of the camera on a web browser. We were able to access the image from an access device like a laptop using the Wireless PC card, by connecting directly to the access point, or from a computer connected to the *UNM* network, or from an independent Internet service provider via the Internet, as put forward by Figure. 4.
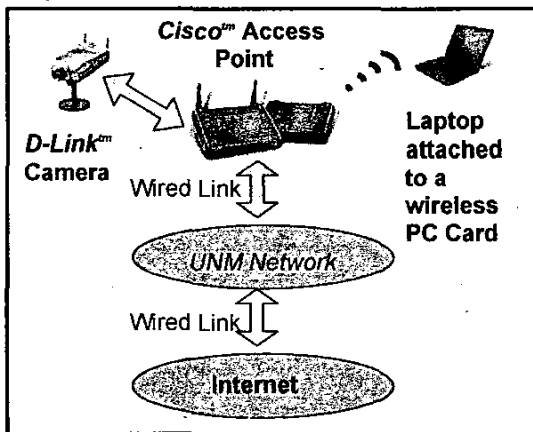

Figure. 4 : Simplified Network Schema for the implementation of the test bed.

The camera sent video stream output through the wireless channel [5]. The true measure of performance is throughput, which is the speed of sending information on the wireless link, over time. In the case of *802.11b* link, management and control frames are also sent along with the data, which cannot count into the throughput [1]. Consequently, the throughput was always be less than the data rate.

Regardless of where the camera was placed, there was always an apparent delay between the image captured and the image displayed. The further away from the access point the camera was placed the longer the delay measured. When an image was not received from the camera, the previous image stayed on until a new image replaced it. Therefore, if there was a significant delay, actual episodes in time would be missed, causing a reduction in throughput. That resulted in the appearance of jerky movements on the video display. The method used to measure the delay was by using an LED timer displaying the seconds. The camera would shoot this timer as it was counting off the numeric seconds while an observer would monitor the numeric changes on the screen of a PC. In the observations, it was noted that not all the seconds were displayed on the screen. In fact, at times depending on the location of the camera, the gaps in lost episodes became quite consistent, as shown in Figure 5.
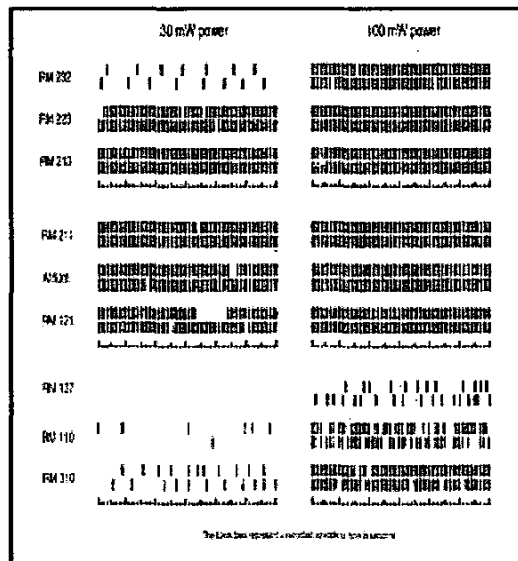

Figure. 5 : Camera survey on all the three floors, at the power settings of 30 mW and 100 mW

From Figure. 5 , we can also see that, for the 30 mW setting, most of the area on the floor having the access point, had uninterrupted camera coverage. But on other floors, camera streaming was very jerky and even non-existent in some rooms. But, with the power level of 100 mW, the reach was much better, and the previously uncovered regions could be reached. But there was a trade off in terms of the security aspect, as a large amount of transmission spilled over to the outside precincts of the building. This phenomenon, as stated before is highly undesirable.
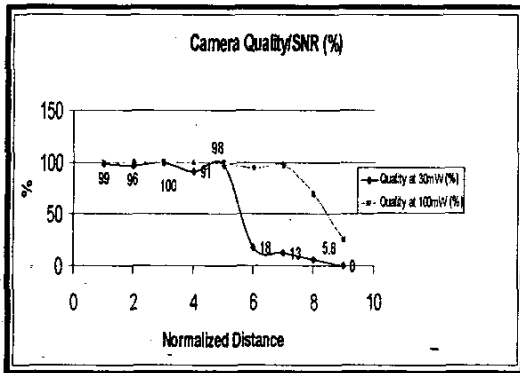

Figure .5 : Camera coverage quality, at 30 mW and 100 mW power levels

We also performed similar *Signal-to-Noise Ratio* analysis for the camera coverage. The data shown in Figure. 6, demonstrates similar trends in the changes of the transmission quality with the power levels. So we reached to a couple of important conclusions:

1. A transmitted power of 100 mW was not desirable. One access point transmitting 100 mW essentially radiated throughout the whole building and outside of the building on the Eastern end.
2. Two access points on each floor transmitting at 20–30 mW, provided optimum coverage on each floor and did not radiate outside of the building. This automatically lead to better camera reception throughout the building premises and also accounted for more number of users on the network, without any appreciable amount of time delays.

3. Real-time video streaming

The real-time video streaming was accomplished, using the facilities of the two conducted surveys and the combination of an access server and a variable rate

distribution server. Live video content provided by a wireless camera through a web server, was accessed.

Access Device	Wireless Link Speed	Image Quality
Laptop	11 MBps	>20 Fps
Pocket PC	11 MBps	>15Fps
Laptop	5.5 MBps	>15Fps
Pocket PC	5.5 MBps	>10Fps

Table 2: Average link speeds and image quality of video streams received by the access devices.

The results, given in Table 2., show the feasibility of the web transmissions with the following observations on the video quality and the wireless links. The received video quality was satisfactory throughout the entire mapped part of the building. It is however important to remember that these measurements were taken on a non saturated wireless medium.

4. Conclusions

We have analyzed the associated issues with real-time video streaming over a wireless LAN infrastructure at the *EECE* Department of the University of New Mexico. The initial site survey and the camera survey gave us useful results and insights, that lead to increased efficiency, higher quality video streams and better utilization of the network capacity.

References

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