모바일 IPv4환경에서 802.11b/g 데이터 전송률과 트래픽 수신에 따른 효율

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Performance of 802.11b/g under Different Data Rates and Traffic Rates in Mobile IPv4 Environment

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요 약

WLAN 기술의 사용은 적은 비용과 손쉬운 WLAN 장비 설치로 인하여 짧은 기간 동안 많은 성장이 있었다. 이러한 기술들은 물리적 계층에서 사용하는 변조에 따라서 1Mbps에서 54Mbps까지 다양한 데이터 전송률을 제공하여 준다. 본 논문에서는 네트워크 시뮬레이터인 OPNET을 활용하여 802.11b와 g에서 모바일 IPv4환경에서 데이터 전송률에 따른 효율과 다른 ESS의 AP사이에서 WLAN station 로밍에 의한 데이터 트래픽 수신에 대한 효율을 분석하였다. 실험결과, 모바일 에이전트에서 핸드오버를 하는 동안 많은 데이터 손실이 있다는 것을 알 수 있었다. 두 가지 WLAN 기술에서 제공해주는 데이터 전송률 기반에 의한 로밍 스테이션의 변화에 의해 트래픽은 수신하였다.

ABSTRACT

The use of WLAN technology specially 802.11 b and g has seen huge subscriber growth in a relatively short time period due to low cost and ease of installation of WLAN hardware. These technologies provide multiple data rates ranging from 1 to 54 Mbps depending on modulation used in physical layer. This paper presents the performance of 802.11b and g under different data rates in mobile IPv4 environment. OPNET is used in the study as the network simulator. The performance metrics used in this work is data traffic received by a WLAN station roaming amongst Access Point (AP) of different ESSs. It is found that much data packets are lost during handover between mobile agents. The traffic received by the roaming station varies based on the data rates provided by two different WLAN technologies.

키워드

802.11b, 802.11g, Mobile IPv4

Ⅰ. Introduction

The Wireless Local Area Network (WLAN) based on 802.11 has grown rapidly to provide network connectivity without the use of wires and the restriction of being tied to a specific location. The simplicity in installation of access points to increase coverage area allowing scalability at minimum cost makes WLAN attractive for public access in cafes, airports, campuses and hotels which are so forth referred as hotspot areas. The widespread implemented

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WLAN technology 802.11b uses DSSS in physical layer and operates at ISM band 2.4 Ghz with multiple data rates 1, 2, 5.5 and 11Mbps. To increase the data transmission rate, 802.11a and 802.11g are developed in last few years[1,2]. However, the inter-operability of 802.11g with 802.11b makes it more popular than 802.11a. The 802.11g standard uses OFDM in physical layer with operation at same 2.4 Ghz and multiple data rates of 6, 9, 12, 18, 24, 36, 48 and 54 Mbps[3].

The mobility of a WLAN user is supported by IAPP (Inter Access Point Protocol) which provides a secure handover mechanism between APs in the same ESS. (Layer-2 solution).For mobility across different ESS, it involves different IP subnets. Mobile Internet Protocol (Mobile IP) provides a solution in such situations that involves the network layer (Layer-3 solution)[4]. The Mobile IP is an extension to the Internet Protocol proposed by the Internet Engineering Task Force (IETF) that addresses this issue. It enables mobile computers to stay connected to the Internet regardless of their location and without changing their IP address. The Mobile IP allows a Mobile Node (MN) to use two IP addresses: Static home address and Dynamic care-of address (CoA) by deploying home agent (HA) and Foreign Agent (FA). The Mobile IPv4 operations include discovering the CoA, registering the CoA, and tunneling to the CoA[5].

In the literature, there are few papers that discuss the throughput performance, high mobility performance with varied conditions like range and packet size and different mobility protocol like MIPv4 and MIPv6, [6-10]. To the best of our knowledge there is no paper that discusses the performance of different data rates under mobile IP protocol.

This paper is organized as follows: Section 2 briefly explains the experimental scenario setup in OPNET simulator. The mobile IPv4 environment arrangement in the experimental scenario is presented in section 3. The performance analysis of 802.11b and g is analyzed under different data rates in section 4. Finally the future work and conclusion is drawn in 5.

Ⅱ. Experimental Scenario Setup

A simplified model of 7 AP, organized in hexagonal honeycell structure as suggested in [9], is setup. The radius of each hexagonal area is set up to 400m. A free space environment is assumed for simplicity which provided high coverage range for each AP than in practical scenario. The APs are placed such that the inter-center distance between two AP is 800m. As such the overlapping coverage area for 802.11b and g is varied based on the data rates. Each AP is connected to internet cloud to access a remote server. Five WLAN stations are placed within the coverage area of each access point to simulate the real life traffic flow congestion. The application used is video streaming with Table 1.

Table 1. Video application attributes
표 1. 영상 응용 특성

Frame Interarrival Time Information		Frame Size Information	
Incoming Stream Interarrival Times (seconds)	Outgoing Stream Interarrival Times (seconds)	Incoming Stream frame size (bytes)	Outgoing Stream frame size (bytes)
Constant (1)	Constant (1)	Constant (1500)	Constant (1500)

The entire traffic is send using UDP. The transmitting power is set to 1mw and the packet reception power threshold is set to -95 dB. The network's performance is tested using OPNET [11] with a single WLAN station roaming in the coverage area of each APs while other stations are stationary. This will provide the snapshot of moderately populated network.

Ⅲ. Implementing Mobile IPv4 in the suggested architecture

In order to implement Mobile IPv4, we deploy home agent and foreign agent in the access points itself by using MIP WLAN router available in OPNET object palette. The simulation utilizes 802.11b or g WLAN interface in each scenario with a single WLAN station with roaming capability, incorporating hand-offs between such mobile IP agent/access points as shown in figure 1. The roaming station i.e. Mobile_IP_NET comprises of a mobile router and a client node. The mobile router utilizes the mobile IP home agent service from HA WLAN router. The mobile router in roaming station is configured with common BSS ID and IP network address as that of HA WLAN router. The redistribution is set to enable in the RIP parameters of Home Agent.

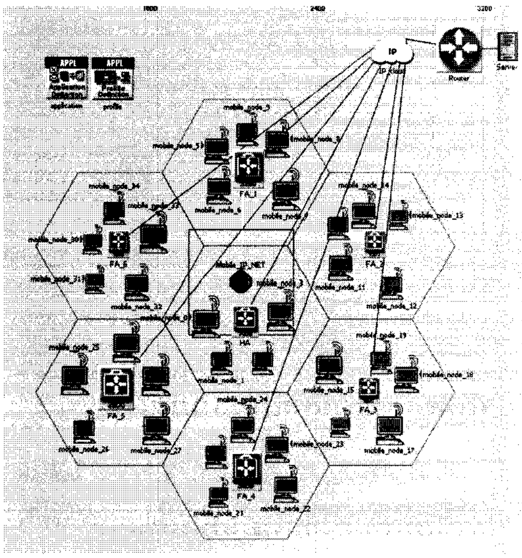

그림 1. OPNET 시나리오 설정
Fig. 1. OPNET scenario setup

IV. Performance Analysis of 802.11b and g

For simulation, the data rate of WLAN is categorized into two modes namely lower data rate (up to 12 Mbps) and higher data rates (above 12 Mbps). For lower data rate analysis, the traffic received for 802.11b under data rates of 5.5 Mbps and 11 Mbps and traffic received for 802.11g under 6 Mbps and 12 Mbps is investigated. For higher data rates, the traffic received for 802.11g under 18 Mbps, 24 Mbps and 54 Mbps is analyzed.

1. Comparison of 802.11b and g under Lower Data Rates

It is found from the simulation that the coverage area of an access point operating at a given transmit power in 802.11b is larger than that of another AP working at the same power in 802.11g as depicted in table 2. The reason behind this fact can be directly contributed to the physical layer transmission type and modulation in each technology. 802.11b uses DSSS for transmission with CCK (Complimentary Code Keying) as mandatory with PBCC (Packet Binary Convolutional Coding) where as 802.11g uses OFDM for transmission with BPSK for 6 Mbps and QPSK for 12 Mbps.

표 2. 전송률을 위한 적용 범위
Table 2. Coverage range for lower data rates

Technology	Data rate (Mbps)	Range (m)
802.11b	5.5	535
802.11b	11	430
802.11g	6	390
802.11g	12	375

As the roaming station enters the coverage area of another access point as described in the above architecture, the hand off takes place ultimately changing the access point connectivity of the station as shown in figure 2. The subnet identifier is represented by vertical axis which is changed after each hand off mechanisms.

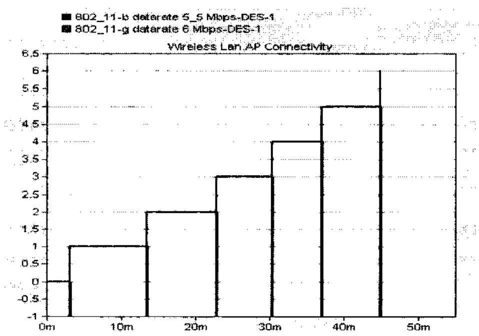

그림 2. AP 상호통신능력
Fig. 2. AP connectivity

High data lost can be seen during the hand off mechanism between mobile agents. Besides that, some data are also lost during normal connection to mobile agents as seen in figure 3 and 4. The traffic received by roaming station is more in 802.11b in both the data rates of 5.5 and 11 Mbps than the closest equivalent data rates of that in 802.11g in 6 Mbps and 12 Mbps.

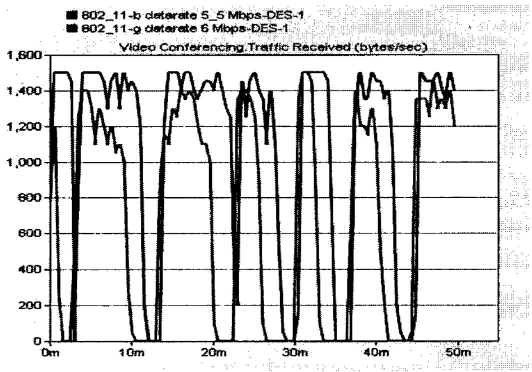

그림 3. 802.11b에서 5.5Mbp 와 802.11g에서의 6Mbps로 받아들이는 트래픽(byte/sec)
Fig. 3. Traffic received in bytes/sec for 5.5 Mbps in 802.11b and 6 Mbps in 802.11g

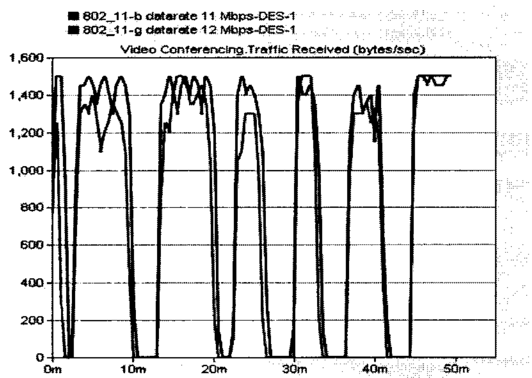

그림 4. 802.11b에서 11Mbp 와 802.11g에서의 12Mbps로 받아들이는 트래픽(byte/sec)
Fig. 4. Traffic received in bytes/sec for 11 Mbps in 802.11b and 12 Mbps in 802.11g

This indicates that under lower data rates, 802.11b provides better performance in terms of coverage area and traffic lost during the overall network connectivity when implemented with PBCC compared to closest equivalent speeds in 802.11g that utilizes OFDM technique.

2. Performance Analysis of 802.11g under Higher Data Rates

With the increase in data rates in 802.11g, it is found that the coverage area is reduced drastically as depicted in table 3.

표 3. 데이터 전송률을 위한 적용 범위
Table 3. Coverage range for higher data rates

Data rate (Mbps)	Range (m)
18	380
24	170
54	75

The modulation scheme used in 18 Mbps is QPSK1, 24 Mbps is 16 QAM and 54 Mbps is 64 QAM. The traffic received under data rate of 18 Mbps exhibits degraded performance while no traffic is received under 24 Mbps and 54 Mbps data rates. The reason behind such outcome is due to limited coverage range of access point in higher data rates with fixed transmit power. The other point that should be considered is sensitivity. With increase in data rates, the sensitivity starts to degrade due to packet error rate. The complete absence of traffic under 24 Mbps and 54Mbps is due to poor sensitivity.

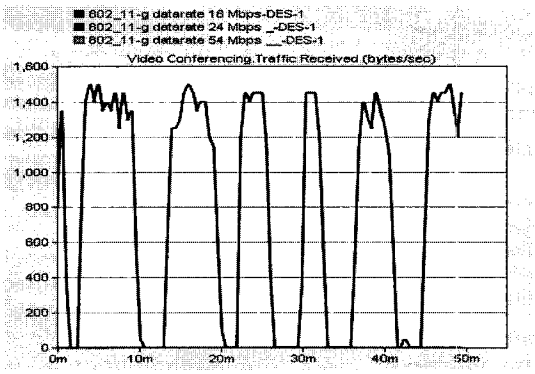

그림 5. 802.11g에서의 18Mbps, 24Mbps, 54Mbps에서 받아들이는 트래픽(byte/sec)
Fig. 5. Traffic received in bytes/sec for18 Mbps, 24 Mbps and 54 Mbps in 802.11 g

A more effective solution would be to increase the output power of the WLAN signals while increasing the signal sensitivity of WLAN equipment. Both factors have a strikingeffect on the range of a particular WLAN network without increasing the cost and complexity by adding extra hardware. For the optimal performance, the transmit power is changed to 5 mw for data rate of 24 Mbps and 10 mw for data rate of 54 Mbps. As the sensitivity of roaming station is not responding properly to the data packets sent by access point under such higher data rates, it has to be changed to -85 dB. Under higher data rates, the receiver requires high degree of acuity. It should be considered that the excess increase in power during the use of such higher order modulation like 16 QAM and 64 QAM leads to desensitize the receiver due to Error Vector Magnitude (EVM). As such, increase in power should be properly monitored. Although higher transmit power and increased receiver sensitivity can raises such issues, designing these capabilities is certainly feasible and will certainly extend the range of typical WLAN deployments.

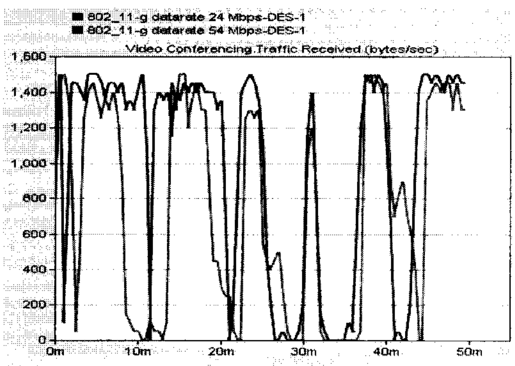

그림 6. 파라미터의 변화를 통한 802.11g에서의 24Mbps, 54Mbps에서 받아들이는 트래픽(byte/sec)
Fig. 6. Traffic Received in bytes/sec for 24 Mbps and 54 Mbps in 802.11g with changed parameters.

The resulting performance with such changed parameters is shown in figure 6. Even with such increase in power, much traffic is lost in 54Mbps compared to that of 24 Mbps. It becomes difficult to maintain the optimum performance with the increase in data rates.

V. Conclusion

For lower data rates network connectivity, 802.11b is more preferable to 802.11g due to better performance in terms of traffic lost and widespread availability. Nevertheless, in the present context of higher mobility, extending from one ESS to another, and use of applications such as multimedia that require higher data rates, 802.11g seems to be apt. With the increase in data rates, it becomes difficult to maintain the optimum performance. The limited coverage area under higher data rates in 802.11g necessitates for installment of more access points to take advantage of higher data rates provided by 802.11g, which is permissible as the cost of installment of additional access points is cheap to coverage provided by it under higher data rates. The other probable solution is higher transmit power and increased receiver sensitivity. In future works, a real life environment with path loss calculations and propagation models will be considered to provide more practical approach.

References

[1] IEEE 802.11std, 1999

[2] IEEE 802.11b, 2001

[3] IEEE 802.11g, 2003

[4] Anand R. Prasad, Neeli R. Prasad, "802.11 WLANs and IP Networking, security, QOS and mobility", artech house, 2005

[5] C. Perkins, IP Mobility Support for IPv4, RFC 3344

[6] Jatinder Pal Singh, Nicholas Bambos, Bhaskar Srinivasan , Detlef Clawin, Wire LAN performance under varied stress conditions in vehicularr traffic scenario, 2002

[7] A. Ipatovs, E. Petersons, Performance Evaluation of WLAN depending on Number of Workstations and Protocols, 2006

[8] Alexander L. Wijesinha, Yeong-tae Song, Mahesh Krishnan, Vijita Mathur, Jin Ahn, Vijay Shyamasundar, "Throughput Measurement for UDP Traffic in an IEEE 802.11g WLAN," snpd-sawn, pp. 220-225, Sixth

International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/ Distributed Computing and First ACIS International Workshop on Self-Assembling Wireless Networks (SNPD/SAWN'05), 2005

[9] Rameez M Daoud, Mohamed A. El-Dakroury, Hany M. Elsayed, Hassanein H Amer, Magdi El-Soudani, Yves Sallez, Wireless Vehicle Communication for traffic control in urban areas, 32nd Annual Conference on IEEE Industrial Electronics, IECON, 2006

[10] S.R. Ramzy, M.M. Milad, R.R Morgan, K.W. Henain, R.Rm Daoud, H.H Amer, Optimiztion of 802.11 b/g Networks for High mobility and Dynamic Data Applications,9th Internatiional Conference on Telecommunications, 2007

[11] Official site of OPNET: www.opnet.com

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