Performance Analysis of 802.11a WLAN in Real Indoor Environments

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ABSTRACT — **A radio LAN (Local Area Network) that do send data using wireless connection attracts interest, and normalized HIPERLAN/2 by ETSI and IEEE 802.11a in 5GHz frequency band. This paper presents the throughput performance 802.11a radio LAN in the real indoor environment. After did modelling the indoor environments, applied SBR techniques and did simulate change of Performance of 802.11a radio LAN by position change of room construction and showed that some position change of room construction influences in radio LAN Performance considerablely..**

I. Introduction

Lately, radio LAN(Local Area Network)s that can exchange data each other using not wire but wireless connection in particular area do appeared and prevailed already[1]. Radio LAN has weak mobility and transmission coverage comparing with 3G mobile communication, but strength in the data transmission speed, base station transceiver system expense. Also there is strength transmission coverage and bandwidth comparing with PAN (Personal Area Network) area that is risen strongly.

Present radio LAN is used extensively in 2.4GHz ISM (Industrial, Scientific, and Medical) band, and standardization is led by ETSI (European Telecommunications Standards Institute) BRAN (Broadband Radio Access Network) and IEEE802.11 WG standard that transmission is available to 54Mbps according to increase of data request of high speed normalized in 5GHz frequency band and is developing.

This Radio LAN is used mainly in the indoor environments and has Performance change according to structure of room building, quality of the material, and furniture arrangement . Go through serious fading that signal that is transmitted from transmitter is received for other direction at other time because undergo multipath reflection from the wall or ceiling, the floor and diffraction from corner of furniture also. Because this causes strong interference in digital communication, information transmission that want is difficult[2].

In this paper, we did throughput performance analysis by C/I ratio through modelling PHY layer and MAC layer according to 802.11a radio LAN standard and introduces SBR (Shoot-and-bouncing)/Image techniques that is kind of ray launch techniques considered reflection and polarization in ceiling and floor, and applied UTD to consider diffraction phenomenon from corner to find path loss variable necessary to yield throughput at specification position .

II. 802.11a Radio LAN Performance Analysis

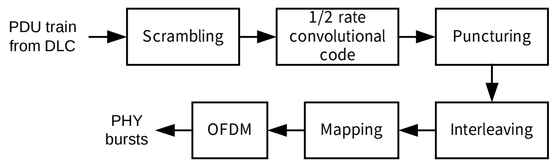

Figure 1 .IEEE 802.11a transmitter block

Physical Layer of 802.11a radio LAN is OFDM by basic structure and transmitter block is same with Figure 1. Input PDU train from high layers is scrambled and passed through covolution code step, interleaver and modulated by subcarrier . In this case it has the different code rate and interleaving size and modultion method according to this transfer rate. 802.11a WLAN can offer 6, 9, 12, 18, 24, 36, 48, 54Mbps' transfer rate using 52 subcarrier (including 4 pilot sub-carrier) , use BPSK, QPSK, 16 - QAM, 64 - QAMs as like various modulation and coding rate 1/2, 2/3, 3/4 for this. Figure 2 shows PER Performance by C/I ratio value about some modes with contents of Figure 1 and 802.11a standardization contents. In the simulation, PSDU's size did by 1500bytes about all modes.

IEEE 802.11a radio LAN uses informed DCF (Distributed Control Function) way that is CSMA/CA basically to approach to medium. DCF has basic access method and selective four-way handshaking technology that it is known as request - to - send/clear-to-send (RTS/CTS) method. Each terminal if signal is not detected (Idle state) more than DIFS (DCF Interframe Space) interval to medium immediately can send frame.

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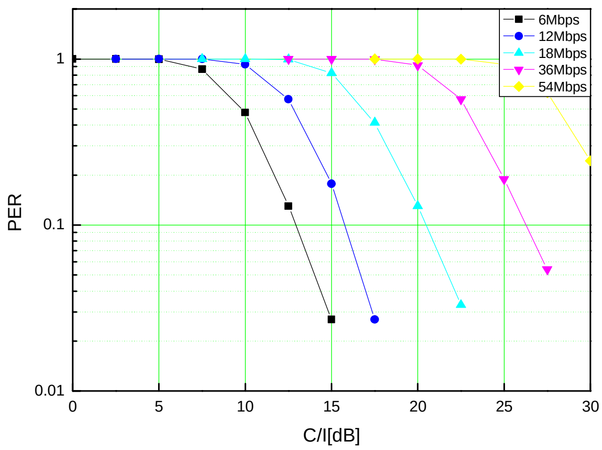


Figure 2 . PER Curve by C/I ratio of IEEE 802.11a WLAN

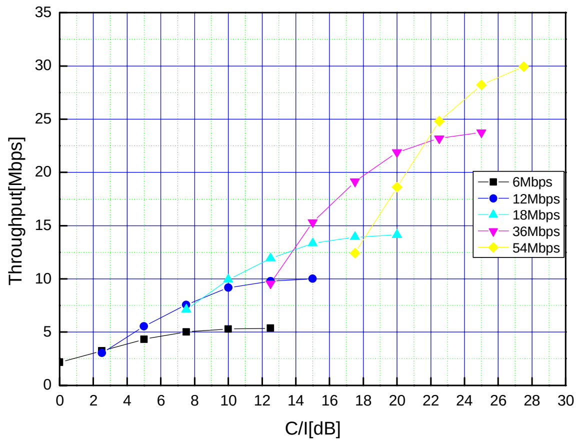


Figure 3. Throughput Curve by C/I ratio of IEEE 802.11a WLAN

But, if signal is detected while waits transmission of a message, terminal waits that medium gets into Idle status again. If medium gets into Idle status, selects backoff time randomly after wait DIFS time, backoff timer reduce timer value . After Backoff time passes, if there is medium in Idle state, terminal sends frame. Terminal that use RTS/CTS method to detect the signal sends a RTS frame first and the terminal that receives this sends again CTS frame.

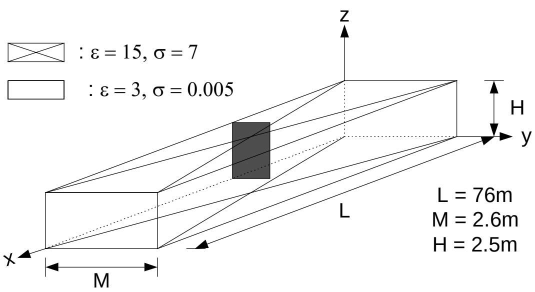
This time, RTS and CTS frame header information include time information that can finish all data, ACK frame exchange. The other terminals that receive one frame of RTS and CTS update own NAV (Network Allocation Vector) to relevant information and suspend transmission of a message attempt for this time

In ideal channel throughput can is defined dividing payload by Transmission cycle [3]. Transmission Cycle is different according to basic access method and four-way handshaking method. Connected each parameter refers IEEE 802.11a MAC parameter of table 1 [5] .BPOS (Bytes/OFDM Symbol) follows according to mode of 802.11a radio LAN.Result that yield throughput by C/I ratio appeared to figure 3 to base so far result[4].

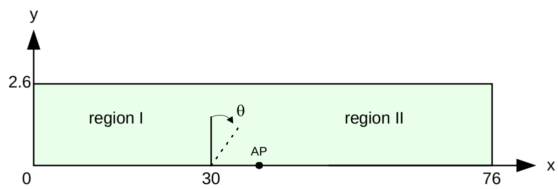
Table1. IEEE 802.11a MAC parameter

Parameter	Duration(μs)
DIFS	34
SIFS	16
Slot Time	9
Back-off time	7.5*9=67.5
PLCP Preamble	16
Signal	4
MAC header	4*[34Bytes/BPOS]
ACK Packet	20+4*[14Bytes/BPOS]
Data Packet	20+4*[(34+PSDU size)/BPOS]

III. MODELLING OF INDOOR ENVIRONMENT



(a)



(b)

Figure 4. Modelling of specific indoor environment

Building of analysis subject is 9 floors of specific school building and there are lecture room and laboratory to both of corridor. Width of corridor is 2.6m

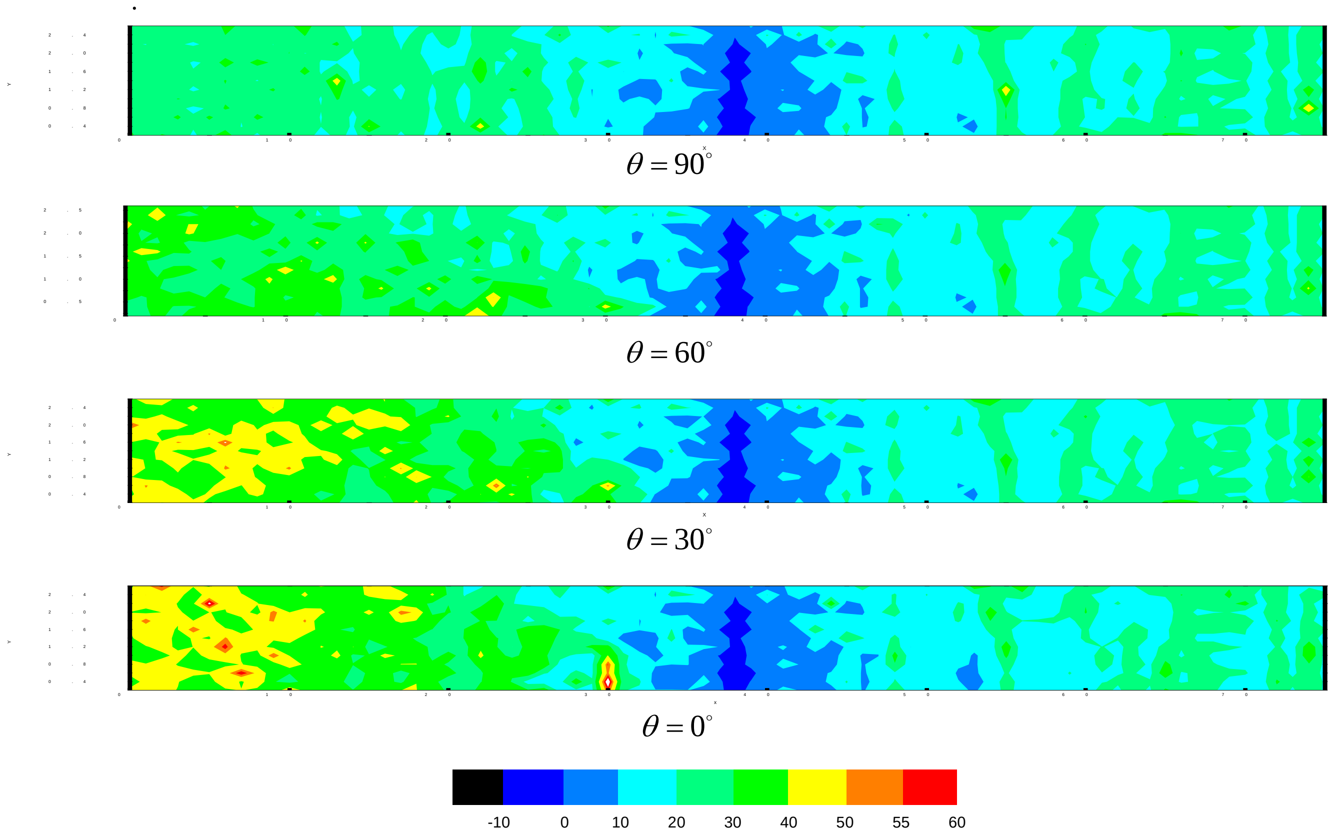


Figure 5. Path loss characteristic by position change of the construction at indoor environments

and length of corridor is 75m , and height from the floor to the ceiling is 2.5m. Figure 4 shows that corridor is modelled as Hexahedron that is length L, width M, height H . Ceiling, floor, and wall were expressed special quality of the material by relative permittivity and conductivity. Supposed that AP is established in the midway of long corridor, there is construction which is composed with iron material near at that, and we wish to show effect by construction that exists in the room forecasting radio LAN Performance at the indoor radio communication.

IV. PERFORMACE ESTIMATION OF WLAIN INDOOR ENVIRONMENT

Figure 5 show propagation characteristic, path loss, by position variation of construction in room structure. We applied SBR (Shooting-and-bouncing) techniques which is a kind of ray launching techniques, and permittivity and conductivity of wall used in the simulation is $\varepsilon = 3$ and $\sigma = 0.005 S/m$,respectively. Permittivity and conductivity of the ceiling and the floor is $\varepsilon = 15$, $\sigma = 7 S/m$.

Supposed that AP's position is (38, 0, 2.4) m, and all point is receiver's position. In the case of $\theta = 0°$, we can see the shadowing region occurred when region I is a reception area because of width of room construction are 1.3m . At this time, path loss is increased because indoor construction get into obstacle that interrupts AP although multiple reflected wave that enter through remainder space diffracted wave through corner of construction enter. Receiving antenna is positioned at region II which is the line of sight. We can see as recedes in the distance of AP as path loss increases and can confirm that path loss at $\theta = 0°$ is small than that of $\theta = 90°$ because construction acts as single reflector and increased received power. In this way, can know that a little position change of construction causes considerable effect in the path loss.

Figure 6 show 802.11a WLAN throughput performance by x-axis distance(y = 0.4m) in region I in the case of $\theta = 0°$ and $\theta = 90°$. In this figure, we fixed the interference amount by fixed value and it is based on Path-loss value that calculated before and radio LAN throughput curved line by C/I ratio to see change of Performance by angle of construction. In the case of $\theta = 90°$ (i.e. in the line of sight) maximum throughput

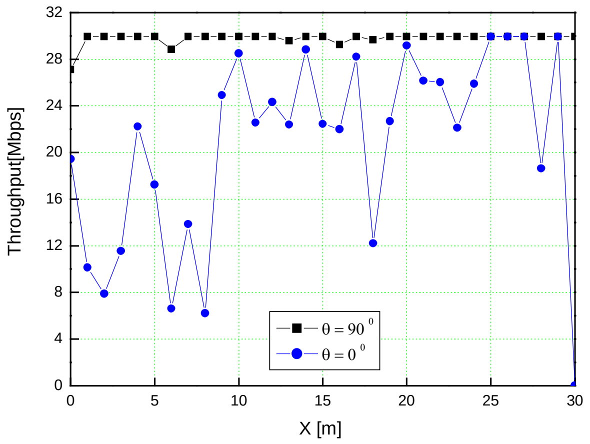


Figure 6. Throughput performance along distance

comes out almost changelessly at each point indeed , but in the case of $\theta = 0°$ (i.e. in the Non-line of sight) maximum difference in the throughput value is about 23Mbps and see Figure 6. Throughput performance along distance that the change amount is much without having fixed throughput. Hereafter, it is confirmed that Position change of construction influence throughput of radio LAN.

V. CONCLUSION

Achieved estimation about Performance of 802.11a radio LAN in the indoor environment that service in 5GHz frequency band station forward in this paper so far. 802.11a radio LAN does Performance analysis by C/I ratio through modeling at PHY layer and MAC layer according to standard, and applied SBR(Shoot and Bouncing)/ Image techniques that is a kind of ray launching techniques to calculate path loss variable. A building which some construction exist at is modeled, we simulated variation of radio LAN performance by position change of room construction, showed that some position change of room construction influences in radio LAN Performance considerablely. From this result, we can know that Performance is not decided only by system Performance when we use WLAN indoors. It must be considered together various kinds constituent of indoor propagation environment (building quality of the material, and existence and nonexistence of construction and arrangement class of construction in building) to decide WLAN Performance. Convince that we can conduce in research for most suitable environment establishment of WLAN service applying this result.

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