ANALYSIS OF INTERFERENCE EFFECT OF THE 802.11A WLAN IN REAL INDOOR ENVIRONMENTS

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1. Introduction

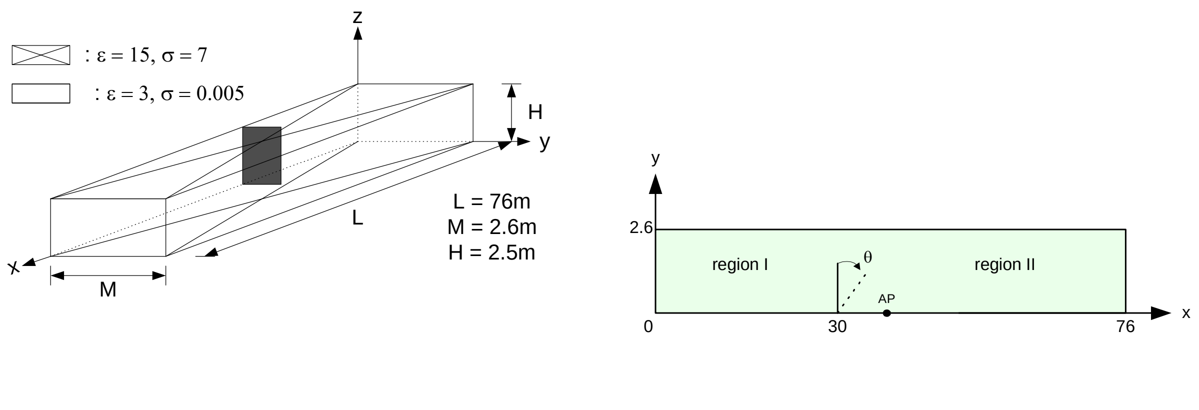
Lately, WLAN (Wireless Local Area Network)s that can exchange data each other using not wire but wireless connection in particular area do appeared and prevailed already [1]. WLAN has weak mobility and transmission coverage comparing with 3G mobile communications, but strength in the data transmission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

Present WLAN is used extensively in 2.4GHz ISM (Industrial, Scientific, and Medical) band. The standardization of WLAN is led by ETSI (European Telecommunications Standards Institute) BRAN (Broadband Radio Access Network) and IEEE802.11 WG. It contains that transmission rate is available to 54Mbps according to the request of high-speed data. It's normalized in 5GHz frequency band and is developing.

The WLAN is used mainly in the indoor environments, so it has gone through serious fading. The signals being transmitted from transmitter are received at other direction at other time because they undergo multi-path reflection from the wall or ceiling, the floor and diffraction from corner of furniture also. The Performance of WLAN changes according to structure of room building, quality of the material, and furniture arrangement. The fading causes strong interference in digital communication, information transmission is difficult [2].

In this paper, the interference effect of the 802.11a WLAN in the real indoor environment is estimated. After did modelling the indoor environments, the SBR (Shoot-and-bouncing)/Image techniques being kind of ray launch techniques is introduced to consider reflection and polarization in ceiling and floor, and UTD applied to consider diffraction phenomenon from corner to find path loss necessary to yield throughput at specific position. The throughput performance by C/I ratio is analyzed through modelling PHY layer and MAC layer according to 802.11a WLAN standard. Also the change of Performance of 802.11a WLAN by position change of room construction is simulated and showed that some positional change of room construction influences in radio LAN Performance considerably.

2. The modelling of real indoor environments



(a) (b)

Figure 1. The modelling of specific indoor environments

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The analysis subject is the specific building of the ninth floors and there are lecture room and laboratory to both of corridor. The width of corridor is 2.6m and the length of corridor is 75m, and height from the floor to the ceiling is 2.5m. Figure 1 shows that corridor is modeled as Hexahedron that is length L, width M, and height H. The Ceiling, the floor and the wall were expressed special quality of the material by relative permittivity and conductivity. It is supposed that AP is established in the midway of long corridor and there is construction which is composed with iron material near at that. We wish to show effect by construction that exists in the room forecasting WLAN Performance at the indoor radio communication.

3. 802.11a WLAN performance analysis

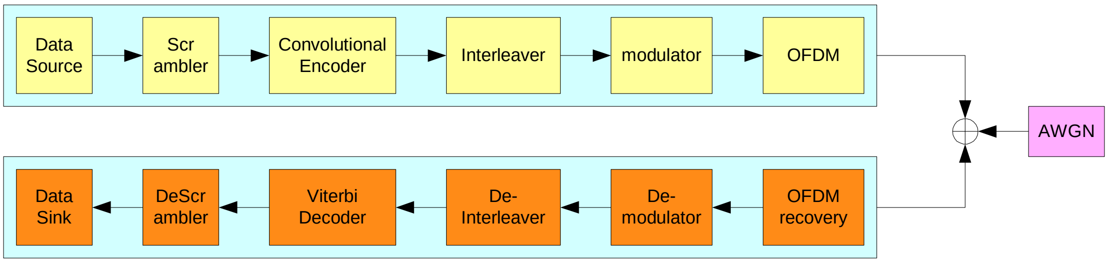

Figure 2. IEEE 802.11a transmitter/receiver block

Physical Layer of 802.11a WLAN is OFDM by basic structure and transmitter block is same with Figure 2. Input PDU train from high layers is scrambled and passed through convolution code step, interleaver and modulated by subcarriers. In this case it has the different code rate and interleaving size and modulation method according to the transmission rate. The 802.11a WLAN can offer 6, 9, 12, 18, 24, 36, 48, 54Mbps transmission rate using 52 subcarrier (including 4 pilot sub-carriers) and uses BPSK, QPSK, 16 - QAM, 64 - QAM as like various modulation and coding rate 1/2, 2/3, 3/4 for this. Figure 3 shows PER Performance by C/I ratio value with block of Figure 2 and 802.11a standardization contents. In the simulation, the size of PSDU is 1500bytes about all modes. The 802.11a WLAN 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. 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 back-off time randomly after wait DIFS time, back-off timer reduce timer value. After Back-off time passes, if there is medium

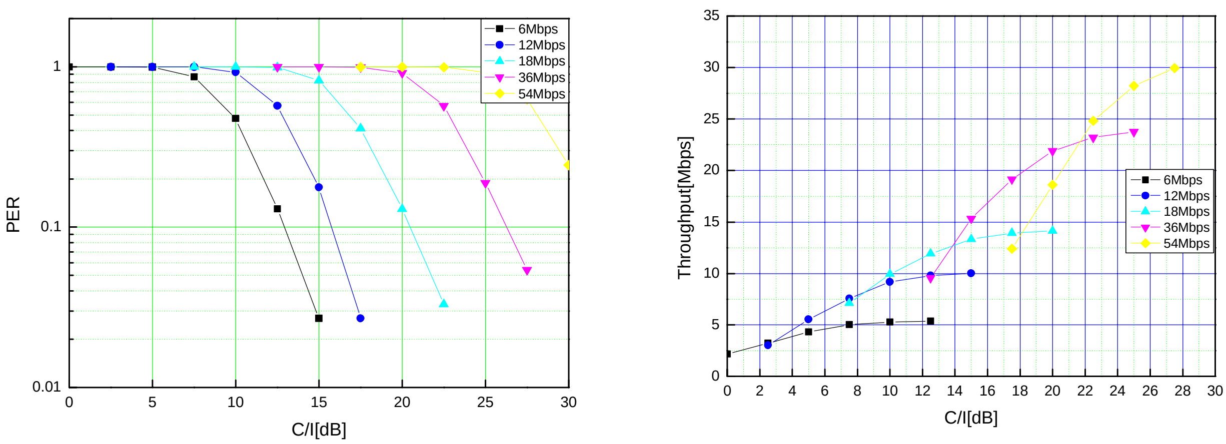

Figure 3. PER/Throughput Curve by C/I ration of IEEE 802.11a WLAN

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 the 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 [5]. BPOS (Bytes/OFDM Symbol) follows according to mode of 802.11a WLAN. Figure 3 shows that throughput by C/I ratio to be based so far result [4].

4. Performance estimation of WLAN in real indoor environment

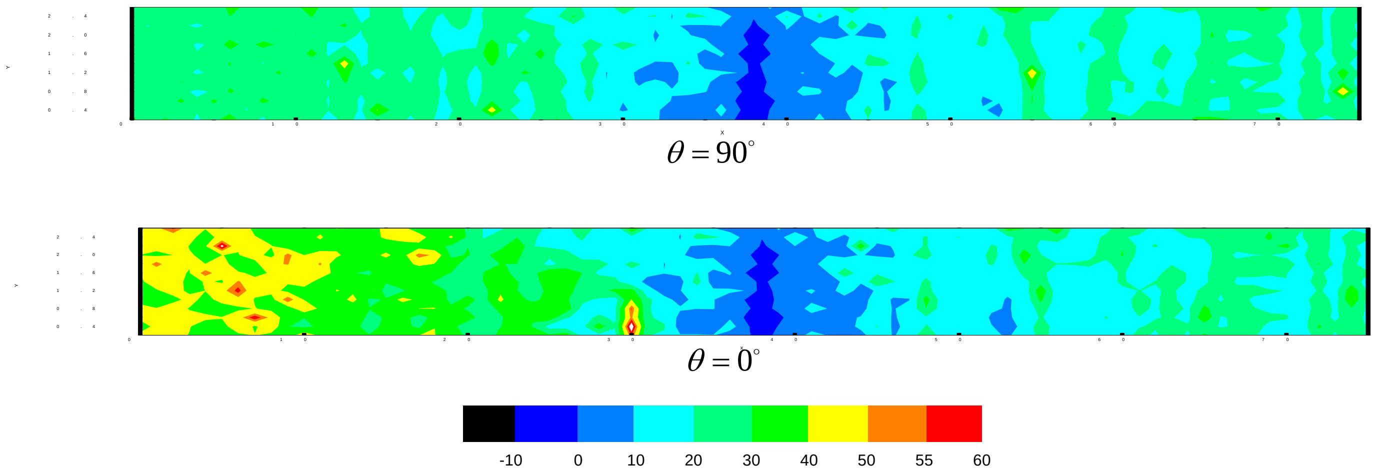

Figure 4. The characteristic of the path loss by position change of the construction

Figure 4 show the characteristic of propagation, path loss, by positional variation of construction in room structure. The SBR (Shooting-and-bouncing) technique is applied, which is a kind of ray launching techniques. The permittivity and the conductivity of wall used in the simulation is $\varepsilon = 3$ and $\sigma = 0.005 S/m$, respectively. The value of the ceiling and the floor is $\varepsilon = 15$, $\sigma = 7 S/m$. It is 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 if region I is a reception area because of width of room construction are 1.3m. At this time, the path loss is increased because the indoor construction get into obstacle that interrupts AP. Although multiple reflected waves are received through remainder space and the diffracted wave through corner of construction is entered. If the Receiving antenna is positioned at region II , there is the line of sight between tx and rx. If the distance from the AP increase, the path loss increases and the path loss at $\theta = 0°$ is small than that of $\theta = 90°$ because construction acts as single reflector and the received power is increased. In this way, a little positional change of construction causes considerable effect in the path loss.

Figure 5 show that the throughput performance of 802.11a WLAN 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. It is based on path-loss value that calculated before and WLAN throughput curved line by C/I ratio to see change of Performance by angle of construction. The C/I ratio varies only according to the positional variation of the construction because of fixed interference strength. As the C/I ratio varies, so the throughput of WLAN varies. In the case of $\theta = 90°$ (i.e. in the line of sight), maximum throughput comes out almost changelessly at each point indeed. In the case of $\theta = 0°$ (i.e. in the Non-line of sight), the maximum difference in the throughput value is about 23Mbps and sees Figure 5. Hereafter, it is confirmed that the positional change of construction influence throughput of the WLAN.

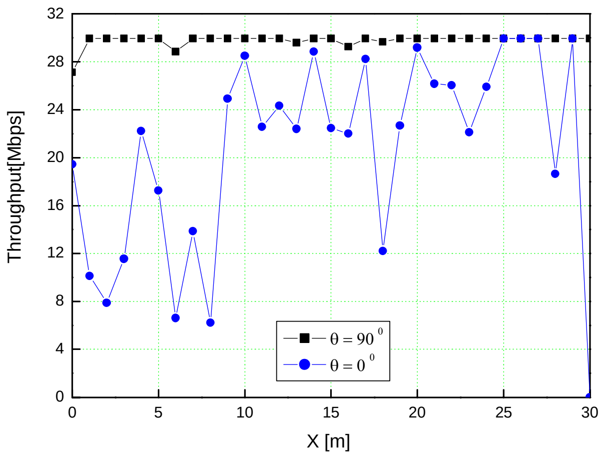

Figure 5. Throughput performance of WLAN along distance

V. CONCLUSION

In this paper, the performance estimation of 802.11a WLAN that will be serviced in 5GHz frequency band forward is achieved at the real indoor environment having interference signal. The 802.11a WLAN 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 where some construction exist is modeled, the variation of WLAN performance by position change of room construction is simulated and showed that some position change of room construction influences in WLAN Performance considerablely. From this result, we can know that Performance is not decided only by system Performance when we use WLAN in 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. These results can be applied in research for most suitable environment establishment of WLAN service.

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