# EFFICIENT CELL PLANNING METHOD BY CONSIDERING INITIAL CONDITIONS

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**Keywords:** WLAN, eell planning, path loss model, indoor environment

## Abstract

This paper focuses on cell planning method and optimal Access Point (AP) location. Cell planning can reduce the adjacent channel interference and minimize the number of AP. So an efficient cell planning method can save cost and time of systems setup. We introduce some methods, compare one another and suggest an efficient method. Existing method is considering a variety of objective functions. So their complexity makes it difficult to design wireless systems. The new method which will be suggested in this paper considering a special condition reduces a lot of calculation quantity.

## 1 Introduction

In deployment of WLAN, finding the optimal location of AP is important issue. Using cell planning, we can reduce the adjacent channel interference and minimize the number of APs. A lot of researches about cell planning have been accomplished. But they are almost about outdoor environment. Unlike outdoor environment, there are different considerations in indoor cell planning caused by obstacles like walls, ceilings, desks and people. To find optimal AP position, we should use the path loss model of the environment and compensate cell location for the specific site. When radio wave goes through an obstacle like concrete wall, it experiences attenuation and service coverage has been reduced. If obstacle is a conduct wall, diffraction phenomenon has been occurred and signal strength has been rapidly decreased. And when it goes on aisle, it experiences a canyon effect which could make cell coverage extended. In order to set up efficient WLAN network, we should consider these effects on indoor cell planning. In this paper, we will introduce several cell planning methods and suggest a simple cell planning method considering initial cell condition.

## 2 Simple cell planning method

We intend to show the channel characteristics of indoor campus environment and provide a cell planning method to improve WLAN system performance. Especially, we focus on wave propagation through concrete wall and conduct wall. Maximum dynamic range of measurement system we used is 95dB. In the campus environment, if there are no obstacles, the radius of a cell coverage is about 25m. Path loss model is given by

$$-PL_{dB} = 10\log\left(G_1 G_2 \left[\frac{\lambda}{4\pi r}\right]^n\right) \quad (1)$$

$\lambda$ : wave number
$r$ : distance between AP and mobile
$G_1, G_2$ : transmitted and received antenna gain
$n=2$ : propagation index through free space
$n=3.4$ : propagation index through indoor environment

When a radio wave goes through a concrete wall, about 10dB additional loss occurs. Thus we should reduce the cell size to about 20m. When wave propagates in the aisle, canyon effect occurs. The canyon effect is that when wave incident angle is large, it experiences a wave-guide effect and then the wave can propagate longer. So cell coverage can be extended to 45m-ellipsoid. We certify this using ray tracing simulation tool and Continuous Wave (CW) measurement.

There are many cell planning methods. First, The representative simple cell planning method is grid installation [2][3][4]. This is to divide the service area into K equally sized rectangles, where K is the number of available AP's and install an AP in the centre of each such rectangle. Using only map, we can install WLAN system without knowledge of the actual propagation characteristics and reduce the probability of coverage gaps. But this simple method has also some weak points. First, it is not easy to divide the service area into K rectangles because of obstacle like walls and stairs. Second, it is unlikely that the access to a backbone infrastructure is readily available at the installation points. To install an AP in the middle of room, we should pay more effort and cost at wiring and installation. Finally, it can waste frequency spectrum resources. Therefore it is hard to adopt grid installation method in real environment. Second method is the automatic cell-planning method[5]. This utilizes objective functions. When we set up a WLAN system, we should consider four global conditions, which are area coverage rate, traffic coverage rate, spectral fitness and economics fitness. On the site where higher density data traffic is needed, we must consider above four global conditions. But on the lower density traffic area, we have to only consider area coverage rate and in this case we utilize the objective function below. [2]

$$g_i^{(k)} = f_a F_i(x,y,z) + n_e \log\left[\max\{1, D_i(x,y,z)\}\right] \quad (2)$$

$$f_1 = \sum_{i=1}^{M} w_i \left(g_i^{(k)} + \mu \max\{0, g_i^{(k)} - g_{i,max}\}\right) \quad (3)$$

$$f_2 = \max\left(g_i^{(k)} + \mu \max\{0, g_i^{(k)} - g_{i,max}\}\right) \quad (4)$$

$$g_{i,max} = (P_0)_{dBm} - (N_0 B) - (F)_{dB} - (SNR_{i,min})_{dB} \quad (5)$$

$g_1^{(k)}$ : path loss from the *i*th point to AP k
$n_e$ : path loss exponent
fa : Wall-attenuation factor
$f_1$ : mini-sum objective function
$f_2$ : mini-max objective function
M : total number of measurement points in the service area.
$P_0$ : the transmit power
$N_0$ : the single-sided spectral noise density
F : the receiver noise figure
$SNR_{i,min}$ : the minimum required SNR
$F_i(x,y,z)$ : Number of wall separating the ith Rx and the Tx
$D_1(x,y,z)$ : Distance between the *i*th Rx and the Tx

But, this method requires a lot of computation, which means the increase of cost and time. So, we suggest adapted grid installation method. Adapted grid installation process is a simple cell planning method using initial conditions. That's not just dividing service area into K sites equivalently but dividing variable size like each classroom size. The process is described as follows:

1. APs are allocated at in the middle of rooms.
2. Overlapped cells are eliminated.
3. The rest of cells are relocated close to the wall.

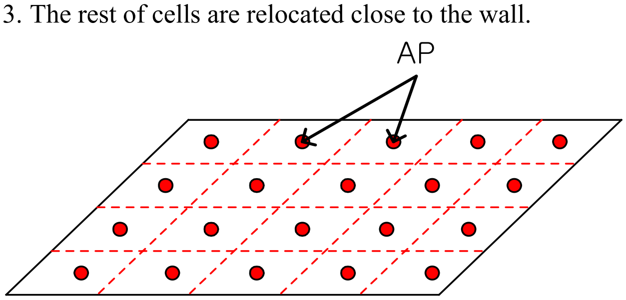



Figure 2. Grid installation

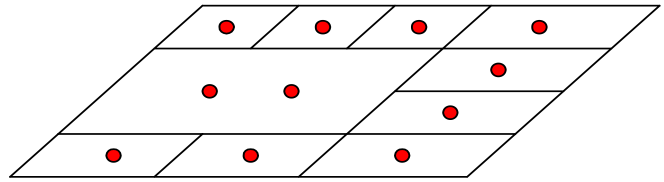
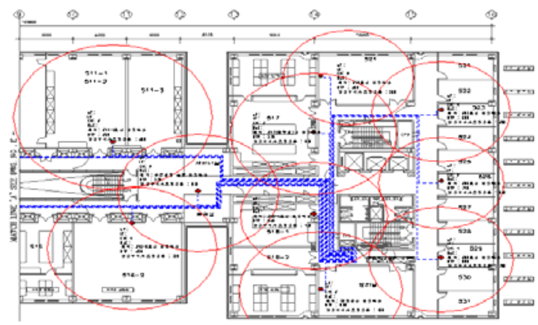
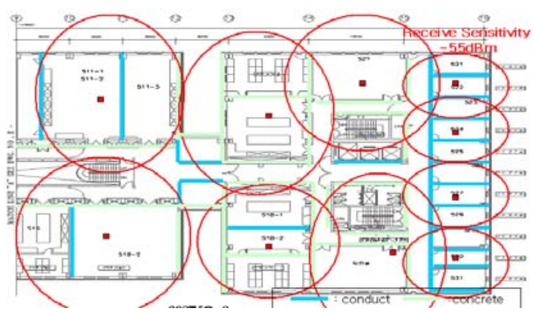


Figure 3. Adapted grid installation

In 2004, Korea Telecom set up WLAN system in Seoul National University. We adapt this new rule to the real environment and compare with the deployed WLAN system. We have much alike the cell planning result.



(a) Cell planning using the measurement




(b) Cell planning using the new method
Figure 4. Cell planning on the campus environment

## 3 Conclusion

In the deployment of WLAN systems, we should find optimal AP location using a cell planning method. The adaptive grid installation which is suggested in this paper can make to set up WLAN systems with less effort and cost.

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