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Wi-Fi Access Point Placement Optimisation Algorithm for Optimal Wireless Coverage, Minimal Co-Channel Interference and Maximal Throughput

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Abstract

Campus Wi-Fi network access point (AP) placement and its wireless coverage optimization requires a shift from simple path-loss (PL) based distance metrics to a data throughput-centric model. Co-channel interference (CCI) avoidance and reliable throughput are achievable by using SINR as an optimization constraint for positioning AP in a bordered geometrical space. This work developed an algorithm for determining the best position for the deployment of an AP with its optimal wireless coverage radius (WCR) within a rectangular border region using three methods - PL threshold based (Method 1) or SINR (throughput) threshold based (Method 2) optimization or optimal weighted combination of both (Method 3). The developed algorithm adopt simplicity and effectiveness of log-distance path-loss (LDPL) model with PL exponent equal to 3 to address distance metric based optimization of Method 1. Furthermore, it achieved Method through sum integral combination of products of α,β and γ weight constants and average throughput, WCR and interference respectively. Realistic input data were provided for the simulation test of developed algorithm using MATLAB (R2025b) installed on Microsoft Windows 11 Operating System and Dell Precision 3530 with Intel® Core™ i5 Processor (Intel® Core™ i5-8400H CPU @ 2.50GHz, 2496 Mhz, 4 Core(s), 8 Logical Processor(s)). The coverage radius obtained from the method 1, method 2 and method 3 were 205.6 m, 192.7 m and 201.9 m respectively. The throughput for the method 1, method 2 and method 3 were 69.81 Mbps, 70.71 Mbps and 65.16 Mbps respectively. The Method 1 maximizes the signal footprint by having the largest coverage area of 205.6 m coverage radius. Nevertheless, it paid a trade-off cost of lower data rates due to the inclusion of areas with marginal SINR. Furthermore, the throughput based optimization (method 2) prioritized maximum distance from interference sources achieving 70.71 Mbps. However, it had a trade-off cost of lowest total coverage area. Finally, Method 3 provided a balanced weighted composite sum solution with a significant moderate average throughput of 65.16 Mbps with coverage area with radius 201.9 m. It had the closest norm separation distance with interring AP like 87.8m from AP 2. The developed algorithm provided the final optimal position for the candidate AP using the solutions from the Method 3. Finally, it is applicable for deployment of APs in high user density area like higher institution campuses, large residential areas, government secretarial complex, and other areas with network device connectivity.

Keywords: Access Points (AP), Path-Loss Models, Optimisation Algorithm, Wireless Coverage Radius (WCR), Minimal Co-Channel Interference, SINR, Throughput

1 Introduction

Co-channel interference (CCI) is a problem that occurs in wireless communication system due multiple wireless devices operating at the same frequency channel. In the case of wireless access points (APs) as wireless communication devices, the algorithm of Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) made it impossible for neighbouring APs to transmit concurrently (Dashora, 2014; Doost-Mohammady et al., 2016; Fairhurst, 2016; Gao et al., 2018; Kleinrock & Tobagi, 1975). Hence, CSMA/CA subside the effects of CCI but the associated technical problem is the waiting time while avoiding collision by each neighbouring AP. The effects of the CCI constraints on Wi-Fi APs could be addressed by avoiding the overlapping of the wireless coverage region of an AP with any neighbouring AP sharing a particular channel or channels together (Fadare et al., 2021, 2023; A. Gupta et al., 2022). Hence, the main targeted optimization variable to be modified as a trade off is the wireless coverage radius (WCR) of the concerned AP (Fadare et al., 2021; Namvar et al., 2019; Safwat et al., 2022; Sawalmeh et al., 2018).

The WCR can be technical derived from the transmitting properties of the AP in relative to its wireless channel transmission specification by the original equipment manufacturer (OEM) (Hou & Gao, 2011; Lee et al., 2020; Safwat et al., 2022; Sánchez et al., 2024). Furthermore, the technical indication of mitigating the effects of CCI on the AP is the achievement of optimal maximum values of its Signal to Interference and Noise Ratio (SINR) and data throughput (Ali et al., 2019; Hasan et al., 2017; Masiukiewicz, 2017; Meng et al., 2023; Shakhatreh et al., 2021; Wu et al., 2024). Technically, both mentioned independent optimization variables could also affect determination of WCR of AP. Therefore, optimal determination of WCR can be subjected to the natural method utilizing its OEM channel transmission related specification or considering the desired optimal SINR and throughput in the presence of other AP as competitor or both. The deployment optimization of wireless local area networks (WLANs) AP for campus environments is an interesting telecommunication engineering challenge. It involve a technical systematic balance between maximizing user throughput ensuring robust and minimizing interference while ensuring optimal wireless network coverage (Easha et al., 2020; Ji, 2017; Khattak et al., 2022). Therefore, the technical placement or deployment optimization of APs addresses the challenge of computing the optimum coverage radius and positions of targeted APs while maximize its SINR and throughput and minimizing CCI.

2 Background Study

The performance of Wi-Fi networks depends heavily on the path-loss model used to predict signal attenuation and the coverage radius of access points (APs) (Lee et al., 2020; L. Ma, 2022; Mao et al., 2018; Mostarac et al., 2022; Sánchez et al., 2024). Accurate modelling ensures optimal placement of APs, efficient resource allocation, and improved user experience. In campus environments, these models are generally categorized into three types deterministic, empirical, and stochastic (Ayidu & Elaigwu, 2023; X. Feng et al., 2022; Joseph et al., 2013; Osahenvemwen, 2020; Pribadi Fitrian et al., 2025; Safna & Manos Dissanayake, 2020; Sridher et al., 2020). Empirical models are derived from extensive measurement campaigns and observations in specific environments (Ayidu & Elaigwu, 2023; Goldratt & Goldratt, 2018; Ju et al., 2020; Konak, 2010; Ratli et al., 2022; Sati & Singh, 2014). Empirical models like Log Distance Path-Loss model are much favoured for their low computational complexity but are environmental specific(Al-Hourani et al., 2014; Fadare et al., 2021; Igbinosa & Okpeki, 2023; Osahenvemwen, 2020; Safna & Manos Dissanayake, 2020; Sridher et al., 2020).

2.1 Relevant Path-loss Models for Campus Wi-Fi AP Networks

Several path-loss models were developed by researchers to predict signal attenuation for wireless networks like

Campus Wi-Fi AP or Hotspot networks (Ayidu & Elaigwu, 2023; X. Feng et al., 2022; Osahenvemwen, 2020; Safna & Manos Dissanayake, 2020). These models differ in complexity and accuracy, with empirical models often outperforming theoretical ones in real-world campus deployments. These are some of the campus environment related path-loss models as discussed in the following subsections.

2.1.1 Friis Free Space Path-loss (FFSP) Model

This model was based on assumption of excellent possibility of line-of-sight (LOS) propagation. It is a highly suitable deterministic model for open outdoor areas like open field of the campus. However, it fails to account for obstacles common in campus environments (Ayidu & Elaigwu, 2023; Fadare et al., 2021; Rappaport, 2024). The underlying theoretical model is the FFSP model equation in (1) that relates signal power of the transmitted signal from the AP (P_t) to the remaining signal power of the signal at the receiver end (P_r), considering the relevant antenna gains of both transmitter and receiver ($G_t\ and G_r$), and power attenuation due to free space propagation path-loss (L_p) and connection components of the systems (L_{CC}).

$$\boldsymbol{P_r(dBm) = P_t(dBm) + G_t(dBi) + G_r(dBi) - L_p(dB) - L_{CC}(dB)} \quad \textbf{(1)}$$

2.1.2 Log-Distance Path Loss Model (LDPL)

Log Distance Path Loss (LDPL) model is the most prevalent used empirical model, for predicting the attenuation of radio signals over distance in various environments. LDPL model was based on the assumption that path-loss increases logarithmically with distance (Fadare et al., 2021; Gulia, 2020; Igbinosa & Okpeki, 2023; Rappaport, 2024) (Azevedo & Mendonça, 2024). It introduces a fantastic independent variable called path-loss exponent to account for environmental factors such as walls and furniture. Therefore, it was considered as an appropriate empirical model applicable to indoor campus scenarios(Ayidu & Elaigwu, 2023; X. Feng et al., 2022; Gulia, 2020; Shakhatreh et al., 2017; Sridher et al., 2020) (Ezeh, Nwogu, & Emerole, 2016). Mathematically, it can be expressed as shown in (2) as an equation to obtain path-loss at target distance *d,* (*PL(d)*) , using path-loss at a reference distance *d0* (*PL(d0)*), environmental based path-loss exponent *n* , logarithm ratio of the target distance (*d*) and reference distance (*d0*), and the log-normal distribution modelled shadowing term (χ_σ).

$$\boldsymbol{PL_d(dB) = PL_0(dB) + 10n\log\left(\frac{d}{d_0}\right) + \chi_\sigma(dB)} \qquad \textbf{(2)}$$

The path-loss exponent, *n*, is environment-dependent with typical values for range from 2 (for free space propagation environment) to 4 (for higher density environment like indoor of complex buildings and urban environments). The shadowing term (χ_σ) accounts for large-scale variations due to obstacles. Hence, it is often modeled as a zero-mean Gaussian random variable (in dB). with a standard deviation (σ) of 4–12 dB (Al-Hourani & Guvenc, 2021; Ayidu & Elaigwu, 2023; X. Feng et al., 2022; Lee et al., 2020; Omariba & Masese, 2019; Rappaport, 2024).

2.1.3 Basic and Advanced Hata Path-Loss Model

The Hata model is an empirical formulation of the graphical data provided by Okumura. It was originally designed to predict signal behaviour in the 150 MHz to 1.5 GHz range (Bavarva et al., 2015; Imoize et al., 2018; Joseph et al., 2013; Mohamed, 2018). For a typical urban environment like campus, the standard Hata Model based formula for path-loss (PL_{Hata}) in decibels (dB) is given in (3). The model obtains the propagation path-loss considering operating frequency of the AP (*f*), antenna height of the AP (h_{AP}), antenna height of the considered receiver (h_R), linear separation distance between the considered receiver (h_R) and some other correction factors as depicted in (3).

$$\boldsymbol{PL_{Hata} = 69.55 + 26.16\log_{10} f - 13.82\log_{10}(h_{AP}) - a(h_R) + [44.9 - 6.55\log_{10}(h_B)]\log_{10}(d)} \qquad \textbf{(3)}$$

Furthermore, the standard Wi-Fi APs operate at 2.4 GHz and 5 GHz. Conversely, the original Hata model has upper bound operating frequency limit at 1.5 GHz. Engineers typically utilize the COST231-Hata Extension model to extend operating frequency range up to 2GHz and further application of correction factors to the 2.4 GHz band (Alumona TL, 2015; Bavarva et al., 2015). Extended Hata model for urban and suburban environments are often useful for some wireless communication applications(Imoize et al., 2018; Shabbir et al., 2011).

2.2 Coverage Radius of Campus Wi-Fi Access Points Considering Path-Loss

The wireless coverage radius (WCR) of a campus wireless AP network coverage region can be basically described as the maximum distance at which a received signal is distinguishably detected and differentiated from noise and interference signals by the receivers associated to the target AP (Easha et al., 2020; Mulyawan, 2011; Prasad, 2003; Rappaport, 2024; Sawalmeh et al., 2018). The WCR of a targeted Wi-Fi AP depends on its operating frequency band, transmit power, antenna design, and environmental conditions. Typically, a 2.4 GHz signals cover larger areas but suffer from interference, while 5 GHz signals provide higher throughput but shorter coverage(Haron et al., 2021; Rappaport, 2024; Shafi et al., 2017). Campus environments are usually characterized by varying building heights and vegetation that can lead to multipath fading and shadowing . Study of results of some simulations and empirical data suggest that for outdoor Wi-Fi (such as Wi-Fi 7), the effective coverage radius are characterized by the signal strength dropping from -40 dBm (near the APs) to -90 dBm (at the fringe boundary of the coverage region) (Easha et al., 2020; H. Ma et al., 2018; Nunns et al., 2019). Usually, the receiver sensitivity is usually around -70 dBm to -80 dBm for reliable Wi-Fi APs (Heijnen et al., 2013; Shamsi et al., 2026; Vijayaraghavan et al., 2023)

2.3 Coverage Radius of Campus Wi-Fi Access Points Considering SINR and Throughput

The determination of the coverage radius of a wireless access point (AP) involves analysing radio propagation, SINR, and throughput performance (A. K. Gupta et al., 2015; Marani et al., 2023; Masiukiewicz, 2017; Zhang & Andrews, 2015). These parameters ensure that users experience reliable connectivity without congestion or dead zones. Signal-to-Interference-to-Noise Ratio quantifies the quality of a wireless link by comparing the desired signal power to interference and noise levels. Fundamentally, the WCR is constraint by the point at which the received signal power (P_{RSS}) can no longer maintain a required SINR threshold for a target throughput. A minimum SINR (often > 20 dB for high throughput) is required to maintain a stable connection. Below this threshold, packet errors increase, reducing throughput (Cileo et al., 2017; Khan et al., 2019; Wu et al., 2024). Mathematically, SINR could be expressed as shown in (4) below for a received signal power ($P_{RSS}(dB)$), noise signal power (P_N) and interference signal power level (P_{INTERF}) (Cileo et al., 2017; S. Feng et al., 2014; Pan & Zhu, 2015; Rappaport, 2024).

$$\boldsymbol{SINR(dB) = P_{RSS}(dB) - 10\log_{10}[P_N + P_{INTERF}]} \quad \textbf{(4)}$$

For the placement of the ith target candidate AP, its received signal power ($P_{RSS,i}(dB)$) among other *n-1* existing wireless APs would face signal interruption from each of CCI signal from each of the (n-1) neighbouring APs that it is sharing same frequency channel with. Therefore, equation (4) is further expressed as shown in (5). Assuming a dense campus environment, the CCI terms ($P_{INTERF,n}$) would dominate the denominator due the possibility of presence of numerous neighbouring APs (Masiukiewicz, 2017).

$$\boldsymbol{SINR(dB) = P_{RSS,i}(dB) - 10\log_{10}\left[P_N + \sum_1^{n-1} P_{INTERF,n}\right]} \quad \textbf{(5)}$$

Determining the WCR in a campus Wi-Fi AP network requires a shift from simple distance metrics to a throughput-centric model. By integrating SINR requirements and localized path loss exponents, engineers can predict the "peak bit-rate area" versus the "total coverage area," ensuring that the density of access points supports the high-bandwidth needs of a modern academic environment. Considering SINR and throughput performance, the WCR radius could be described as the maximal distance from the AP where SINR remains above the acceptable threshold (Marani et al., 2023; Rappaport, 2024). For campus Wi-Fi, typical WCRs range from 30 to 50 metres for the indoor Wi-Fi networks and 100 to 150 metres for the outdoor Wi-Fi networks based on antenna type and environmental terrains.

3 Methodology

The model was typically designed for a deployment optimization 2.4 GHz Campus Wi-Fi APs in a well defined 2D rectangular spatial bordered campus. Figure 1 shows the procedural process of the developed algorithms for the model. The algorithm was designed based on a range of realistic assumptions like:

(i) a two-dimensional (2D) rectangular campus area;
(ii) detailed AP and antenna specifications like receiver sensitivity and noise figure
(iii) a log-distance path loss model implementation;
(iv) modelling of interfering APs considering the three non-overlapping Wi-Fi channel options - channel 1, 6 and 11; and
(v) a throughput model based on the Shannon capacity approximation.

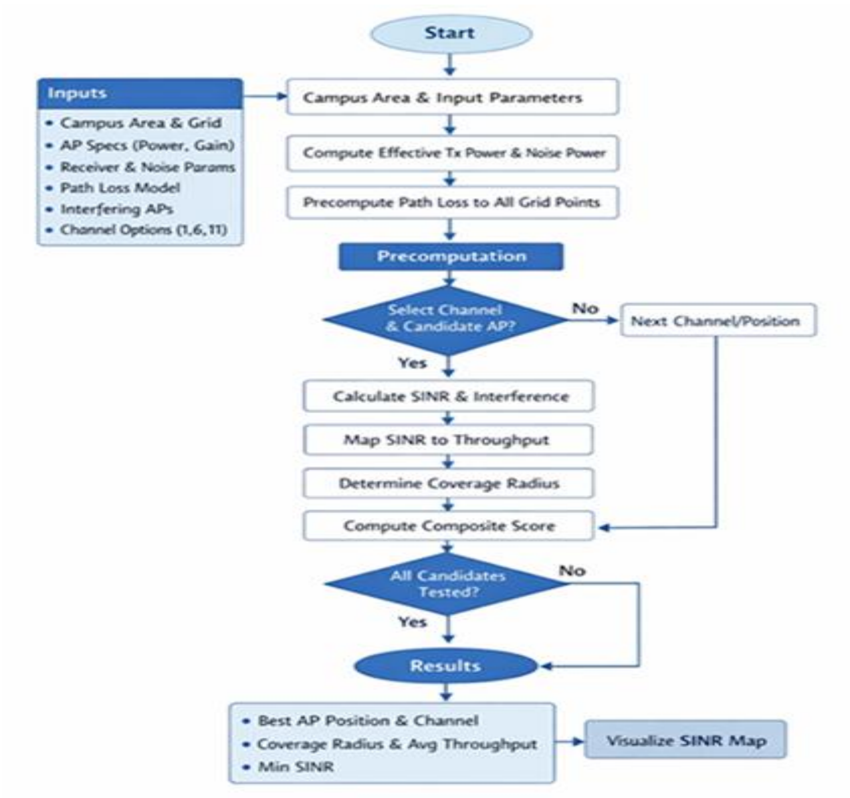

Figure 1: Flowchart for the Developed Wireless AP Placement Optimisation Algorithm

The algorithm in Figure 1 was implemented on MATLAB software (Version 25.2.0.3042426 (R2025b) Update 1) installed on Microsoft Windows 11 Operating System (Microsoft Windows 11 Pro Version 10.0 (Build 26200)) and Dell Precision 3530 with Intel® Core™ i5 Processor (Intel® Core™ i5-8400H CPU @ 2.50GHz, 2496 Mhz, 4 Core(s), 8 Logical Processor(s)). The ultimate objective for this wireless AP deployment optimisation are to obtain optimal position and WCR for the APs subject to

(i) minimum CCI and overlapping of coverage regions from neighbouring APs which was achieved using LDPL model in (2).
(ii) maximum SINR and throughput for all users considering interference from neighbouring APs which was achieved using the model in (5).
(iii) Ensure reliable wireless network services coverage of every users within the WCR of the target (candidate) AP by ensuring their received signal power indications (RSSI) are above the defined receiver sensitivity thresholds.

Table 1: Illustration of the detailed operation of the algorithm

Step	The developed algorithm for the wireless AP placement optimization	
1.	Begin	Start the Algorithm
2.	Inputs	1. Campus geometry: Rectangular area [$x_{min}, x_{max}; y_{min}, y_{max}$] 2. AP specifications: Transmit power $P_t(dBm)$, transmit antenna gain $G_t(dBi)$, and cable and connector loss $L_c(dB)$. 3. Receiver parameters: Sensitivity $P_{RSS,min}$(dBm), noise figure NF(dB) and bandwidth B(Hz). 4. Path loss model: Reference loss $PL(d_0)$ at $d_0 = 1\ m$, path loss exponent n, shadowing standard deviation σ . 5. Interfering APs: Positions (x,y), operating channels, and effective transmit power, $P_{t,eff}$. 6. Channel set: Channel 1, 6, 11}with overlap weights $w(c_1,c_2)$. 7. Throughput model: Approximate Shannon capacity mapping from *SINR* to Mbps, threshold at *150 Mbps*.
3.	Grid Initialization	1. Discretize the campus into evaluation points with resolution *(dx, dy)*. 2. Define candidate AP positions as all grid points.
4.	Effective Transmit Power Computation	$P_{t,eff}(dB) = P_t + G_t - L_C$
5.	Noise Power (N) - Computation	$N_{thermal} = 10\log_{10}(k_B B T_0) + 30\ dBm$ $N = N_{thermal} + NF$
6.	Candidate AP position path-loss computation PL(d) using LDPL Model	$PL(d) = PL(d_0) + 10n\log_{10}\left(\frac{d}{d_0}\right) + \chi_\sigma$ $P_r(d) = P_{t,eff} - PL(d)$
7.	Interference Computation	Considering each received power from the n-1 interfering APs, ($P_{r,i}(d)$) and overlapping weight values w(c, c_k) $I(d) = \sum_{i=1}^{n-1} w(c, c_i).10^{(P_{r,i}(d)/10)}$
8.	SINR Computation	$SINR(d) = \frac{10^{(P_r(d)/10)}}{10^{(N/10)} + I(d)}$ $SINR(dB) = 10\log_{10} SINR(d)$
9.	Wireless Coverage Radius (WCR)	1. According to LDPL Model $WCR = covRad = \max_{P_r(d) \geq P_{RSS,min}} (d)$

	Computation	2. According to SINR and Throughput Performance Index $$WCR = covRad = \max_{SINR(d) \geq SINR_{min}} (d)$$
10.	Throughput Mapping	1. Apply SINR-to-Mbps function to all covered points. 2. Compute average throughput within coverage (AvThrp).
11.	Performance Metrics	1. Minimum SINR within coverage. 2. Coverage area = number of valid points × dx.dy 3. Composite score: $$Score = \alpha.(AvThrp) + \beta.(WCR) - \gamma.(I_{coverage})$$ $$Where\ \alpha, \beta\ and\ \gamma\ are\ constant\ weights$$
12.	Optimization	1. Repeat the algorithm steps from 6 to 10 for all candidate positions and channels. 2. Select best AP placement by: (i) Maximum composite score (Score) (ii) Maximum average throughput (AvThrp) (iii) Maximum coverage radius (WCR)
13.	Visualization	1. Generate SINR heatmap across the campus for the selected AP. 2. Overlay AP and interfering AP positions.
14.	Outputs	1. Optimal AP position (*x,y*). 2. Selected operating channel. 3. Wireless coverage radius (WCR) (m). 4. Average throughput (AvThrp) (Mbps). 5. Minimum SINR within coverage (dB). 6. SINR distribution map across the campus.
15.	End	Stop the algorithm

The developed algorithm was run based on the following input parameters displays inside Table 2 to Table 6:

Table 2: Geometrical parameters for campus 2D surface area

Geometrical parameters	Values
The defined rectangular campus area	$[x_{min}, x_{max} ; y_{min}, y_{max}] = [0, 400m ; 0, 250m]$
Simulation grid resolution	$[dx ; dy] = [4m ; 4m]$

Table 3: AP specifications for the input parameters of the developed algorithm

The AP related input parameters	Values
WiFi carrier transmit center frequency (channel 6) of the AP	$f_{c,AP} = 2.437$ GHz
Radio transmit power of the AP	$P_t(dBm) = 20\ dBm$
Transmit antenna gain of the AP	$G_t(dBi) = 3\ dBi$
Cable loss	$L_C(dB) = 1\ dB$

Table 4: Relevant receiver and Noise Figure parameters

Receiver and noise figure parameters	Values
Received signal power threshold	$P_{Rss,min}(dBm) = -90\ dBm$
Noise Figure	$NF = 7\ dB$
Channel Bandwidth	$B = 20\ MHz$
Reference Operating Temperature in Kelvin (consider 30^{0}C for Nigeria)	$T_0(K) = 303\ K$

Table 5: LDPL propagation model parameters

Propagation parameters	Values
Reference distance	$d0 = 1\ m$
Reference path-loss	$PL(d0) = 40\ dB$
Log normal shadow	$\chi_\sigma = 6\ dB$
Path-loss exponent for the campus environment	**n = 3**

Table 6: Interference and performance target threshold parameters

Interference and SINR parameters	Values
Interfering APs	Two neighbouring APs considered (i) $(x_{i1}, y_{i1}) = (60, 40)\ at\ channel\ 1$ (ii) $(x_{i2}, y_{i2}) = (140, 80)\ at\ channel\ 11$
2.4 GHz WiFi non-overlapping channel	$Channel\ 1, 6\ and\ 11$
Minimum SINR	$SINR_{min} = 5\ dB$

4 Results and Discussion

As illustrated in Figure 1 and Table 1, the Matlab code scripts were written to implement the algorithm to simulate the campus Wi-Fi access point placement optimisation for optimal wireless coverage radius subject to minimal co-channel interference with maximal SINR. The required input parameters for the algorithm were as presented in Table 2 to Table 6. The obtained results were as presented in Table 7 and Figure 2.

Table 7: Interference and performance target threshold parameters

S/N	Output Parameters	AP Position (x_{i2}, y_{i2})	Frequency Channel	Coverage radius (WCR)	Average Throughput ($AvThrp$)
1.	Best by coverage radius	(236.0, 124.0) m	Channel 6	205.6 m	69.81 Mbps
2.	Best by throughput only	(256.0, 120.0) m	Channel 6	192.7 m	70.71 Mbps
3.	Best placement by combined score	(208.0, 136.0) m	Channel 6	201.9 m	65.16 Mbps

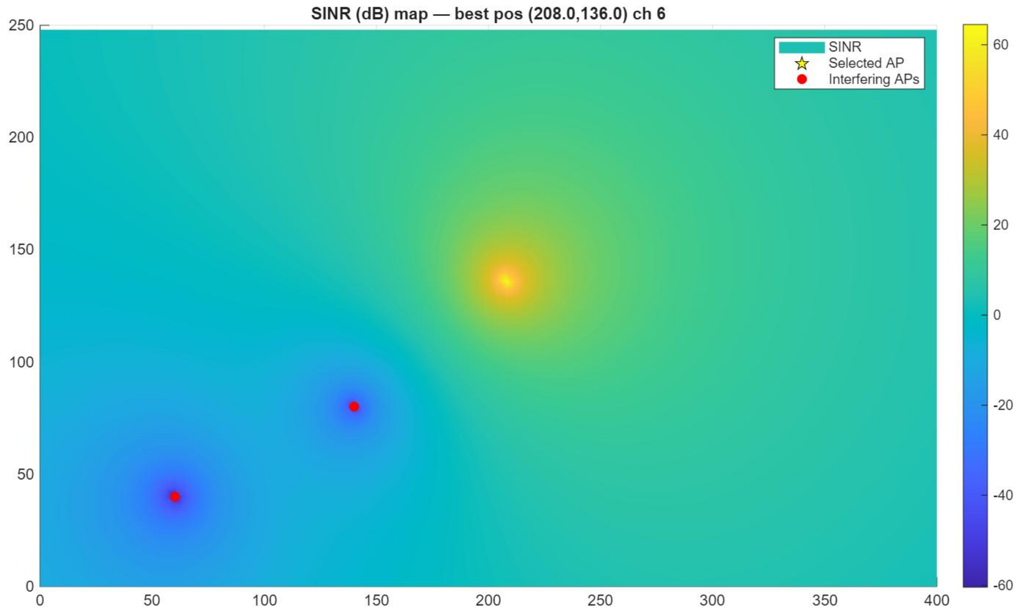

Figure 2: Heatmap of the optimal positioning of the target AP with 2 interfering APs

The best position for the AP proffered by consideration of throughput (via SINR) was (256.0, 120.0) m. The position was observed to be closer to the centre of the grid or further away from the two interfering APs. It traded off about 13 meters of its coverage radius to pull out an extra 5.5 Mbps of speed. This might satisfy preferred AP placement spot in a high-density student lounge. Conversely, the best position by only considering maximal coverage through LDPL model was (236.0, 124.0) m. This alternative position of the AP towards a location with accessible link to most grid points as shown in Figure 2. In addition, the WiFi coverage region gained the largest footprint (205.6 m). However, this alternative option loses some peak throughput compared to the throughput-optimized version. The combined placement options harnessed the utilization of weights to the major optimization variables to obtain the best optimal position (208.0, 136.0) m as shown in section 11 of the algorithm in Table 2. Therefore, as ilustrated in Figure 2, the developed algorithm optimally deployed the campus Wi-Fi AP balancing the maximization of both coverage area and SINR (and throughput) of the AP while minimizing interference from neighbouring APs.

Table 8 illustrates the analytical comparison of the optimal positions of the targeted candidate proffered by the three incorporated optimization method inside algorithm with the positions of the two given interfering APs for testing the algorithm. The PL based distance metric method proffered a position that balances the distance between the centre of the campus and the interference sources to maximize the total coverage area where the signal remains above the receiver sensitivity threshold (minimum received signal strength). The method is appropriate for central placement of AP for the wireless network service of users within the given bordered region.

The second method based on throughput had the furthest norm separation distance between the candidate AP and both interferer APs. It maximized the norm separation distance from interference sources. This incorporated placement optimization method produced the highest SINR and subsequently, the highest throughput of 70.71 Mbps. Effectively, the method assured relatively the lowest noise from the other interfering APs compare to both incorporated alternative methods in the algorithm.

Table 8: Analysis of the optimal positions of the candidate AP with the interfering APs

Optimal position parameters of the candidate AP	Interfering AP 1 (60, 40)	Interfering AP 2 (140, 80)
PL_Distance_metric Method 1 Position = (236, 124) , WCR = 205.6	195.03 m	105.55 m
Throughput based Method 2 Position= (256, 120), WCR = 192.7	211.66 m	122.64 m
Combo Weighted Method 3 Position (208, 136) , WCR = 201.9	176.36 m	*87.82 m*

Furthermore, considering the analysis in Table 8, the method of composite integral combination of the distance metric and throughput based optimization proffered the closest optimal position of the candidate AP to both given interferers. For example, it had smallest norm distance of 87.82 m from AP 2 when other methods had 105.55 m and 122.64 m. Although, there would be possibility of interference due to closest to sources of interference, its specified optimal position coordinate, (208, 136), provided a more central view of the campus area (0 - 200 m range). The relative benefit of this method in the algorithm was that it exposed the fact that the gain in coverage and central location outweighed the penalty of being slightly closer to interfering AP 2.

5 Conclusion

The one of the major challenges of telecommunication engineers is balancing wireless communication coverage, throughput and CCI or any other form of interferences. Provision of campus Wi-Fi AP wireless communication is not exempted. Therefore, the developed optimization algorithm achieved the ultimate objective for this wireless AP deployment optimisation by obtaining optimal position and wireless coverage radius for a target AP despite the presence of two interfering APs. It minimize the CCI and overlapping of coverage regions from neighbouring APs by ensuring they are located in different frequency channel (channel 1 and 11) from its own channel (channel 6) and its covered users with SINR greater than -60.41 dB. Furthermore, the developed algorithm incorporated three methods to obtain the optimal position and coverage radius of the candidate AP in the presence of neighbouring interfering APs. The first incorporated method (Method 1) involved the utilization of LDPL based distance metric AP placement optimization with PL exponent of 3 for the campus related. The second incorporated method (Method 2) utilized throughput for the optimal AP positioning. The third method (Method 3) was a composite combination of the other two method utilizing integral combination of the weighted coverage radius, throughput and interference. The coverage radius obtained from the method 1, method 2 and method 3 were 205.6 m, 192.7 m and 201.9 m respectively. The throughput for the method 1, method 2 and method 3 were 69.81 Mbps, 70.71 Mbps and 65.16 Mbps respectively. The Method 1 maximizes the signal footprint by having the largest coverage area of 205.6 m coverage radius. But it paid a trade-off cost of lower data rates due to the inclusion of areas with marginal SINR . The throughput based optimization (method 2) prioritized maximum distance from interference sources achieving 70.71 Mbps. However, it had a trade-off cost of lowest total coverage area. Finally, Method 3 provided a balanced weighted composite sum solution with a significant moderate average throughput of 65.16 Mbps with coverage area with radius 201.9 m. It had the closest norm separation distance with interring AP like 87.8m from AP 2. This means the interfering signal is significantly stronger here than at the Throughput position. This balanced weight solution of Method 3 was utilized by the developed algorithm for provision of the optimal positions for the candidate AP. Finally, the algorithm is applicable for optimal deployment of APs with the multiple objective of having minimum overlapping of coverage region and CCI with maximum throughput. Therefore, it is applicable for deployment of APs in high wireless network user density area like higher institution campuses, large residential areas, government secretarial complex, large company complex and other areas with network device connectivity.

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