


# RECIPROCITY-GUIDED JOINT BASE STATION PLACEMENT AND FLIGHT CORRIDOR PLANNING FOR URBAN AIR MOBILITY

Yingjie He[1], Yikang Wang[1], Fangyi Wu[1], Jiang Guo[1] & Zhenyu Gao[1]

[1]The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong

## Abstract

Reliable wireless connectivity is essential for safe Urban Air Mobility (UAM) operations in dense urban environments, where high-rise buildings cause severe blockage and multipath propagation. Conventional base station (BS) deployment strategies usually pursue wide-area coverage, which may lead to redundant infrastructure since UAM communication demand is mostly concentrated along flight corridors. This work investigates the joint optimization of BS placement and flight corridor planning in low-altitude urban airspace, aiming for cost-effective communication infrastructure planning for UAM. The proposed method is an iterative approach combining 3D ray tracing and the principle of reciprocity. It first plans communication-free reference corridors, then treats sampled UAV waypoints as virtual transmitters and uses channel reciprocity to infer promising BS locations. The selected BSs are verified using forward radio maps generated with 3D ray tracing, and communication-aware paths are replanned under signal-to-noise ratio constraints. Experiments in a digital-twin urban scenario, reconstructed from OpenStreetMap data and simulated using Sionna RT, demonstrate that the proposed method achieves lower deployment-and-flight cost than a conventional wide-area coverage baseline.

**Keywords:** Urban air mobility, Communication infrastructure, Base station deployment, Flight corridor planning, Channel reciprocity, Ray tracing

## 1. Introduction

Urban Air Mobility (UAM) is expected to provide efficient low-altitude transportation services for passenger mobility, logistics, emergency response, and urban monitoring [1]. By using the three-dimensional airspace above cities, UAM can reduce the pressure on ground transportation systems and support future smart-city operations. As envisioned, UAM will operate as a networked system, where flight corridors connect different vertiports and waypoints and serve the origin-destination (O-D) pairs in the network [2, 3].

However, ground and communication infrastructure is regarded as a main constraint for the UAM system [3]. Reliable wireless connectivity is a fundamental requirement for safe UAM operations [4]. In dense urban environments, high-rise buildings create severe line-of-sight blockage, shadowing, and multipath propagation. These effects can interrupt the communication link between aerial vehicles and ground infrastructure, especially when the aerial vehicle navigates through urban canyons. Therefore, the communication infrastructure for UAM should be planned together with the flight corridors rather than considered as an independent network layer [5].

A straightforward solution is to deploy base stations (BSs) to maximize the covered area. Nevertheless, this objective is not fully aligned with UAM operations. Unlike conventional cellular users that may appear across the whole service region, UAM vehicles mainly require reliable connectivity along planned flight corridors. Therefore, a path-centric deployment strategy can avoid redundant coverage in irrelevant areas and reduce infrastructure cost.

This paper investigates the joint planning of BS placement and UAM flight corridors. The core idea is to co-plan air routes and BS positions using channel reciprocity – i.e., leveraging the principle of reciprocity in the communication domain. In a static urban environment, the propagation condition between a UAV waypoint and a BS location is approximately invariant when the transmitter and receiver are interchanged [6, 7]. Hence, UAV waypoints on a tentative flight corridor can be used as virtual transmitters to identify promising BS locations in the reverse direction. These locations are then verified by forward ray-tracing radio maps and used to replan communication-aware paths.

The main contributions of this paper are summarized as follows:

- A joint BS placement and flight corridor planning problem is formulated for low-altitude UAM under obstacle avoidance and communication quality constraints.
- A reciprocity-guided iterative greedy method is proposed to select path-relevant BS locations and replan communication-aware corridors.
- Simulation results show that the proposed method reduces the total deployment-and-flight cost compared with a conventional wide-area coverage baseline.

## 2. Related Work

BS deployment has been widely studied for terrestrial cellular networks. Conventional approaches often optimize wide-area coverage, handover performance, or service cost over a geographical region [8, 9, 10, 11]. These methods are effective when users are distributed over a service area and the network objective is to provide broad spatial availability. However, they can be inefficient for UAM because aerial vehicles do not require uniform coverage over the entire urban region. Instead, their communication demand is concentrated along regulated flight corridors and near vertiports. A deployment optimized only for area coverage may therefore allocate resources to locations that contribute little to actual UAM operations.

Communication-aware UAV path planning has also attracted increasing attention. Existing studies plan UAV trajectories using radio maps or coverage maps so that the vehicle avoids communication outage regions [12, 13, 14, 15]. These studies demonstrate that radio information can significantly improve the reliability of UAV navigation in urban environments. Nevertheless, most of them assume that the BS infrastructure is already fixed. Under this assumption, the UAV path can only adapt to the existing coverage distribution. If the infrastructure is not aligned with the desired UAM routes, the planned trajectory may need to take large detours or may even become infeasible under strict communication constraints.

The joint optimization of communication infrastructure and UAV corridors is therefore a more suitable direction for low-altitude urban airspace. Related studies have shown that communication resources should be planned according to UAV mobility patterns rather than only according to static geographical coverage [16, 17, 18]. However, joint BS-corridor optimization remains challenging because it combines a combinatorial BS placement problem with a constrained path planning problem. In dense urban scenarios, this difficulty is further increased by building blockage and site-specific propagation effects.

This paper focuses on a lightweight reciprocity-guided co-design strategy. The proposed method uses tentative UAV corridors to guide BS placement through channel reciprocity, and then replans the corridors using forward radio-map verification. In this way, BS deployment and corridor planning are updated in a closed loop without exhaustively searching all BS-path combinations.

## 3. Problem Formulation

We consider a low-altitude urban airspace containing a set of vertiports and a set of origin-destination (OD) flight demands. Let

$$D = \{(o_m, d_m)\}_{m=1}^{M_D} \tag{1}$$

denote the set of OD pairs, where $o_m$ and $d_m$ are the origin and destination vertiports of the $m$-th demand.

The UAV is assumed to fly on a fixed cruising altitude. The corresponding two-dimensional flight plane is denoted by $\Omega_{\mathrm{UAV}}$. The obstacle region projected onto this plane is denoted by $\Omega_{\mathrm{obs}}$. A feasible path for OD pair $m$ is represented as

$$\pi_m = \{\mathbf{s}_{m,1}, \mathbf{s}_{m,2}, \ldots, \mathbf{s}_{m,N_m}\}, \tag{2}$$

where $\mathbf{s}_{m,n} \in \Omega_{\mathrm{UAV}}$ is a UAV waypoint. The path set for all OD pairs is

$$\Pi = \{\pi_1, \pi_2, \ldots, \pi_{M_D}\}. \tag{3}$$

Let $\Omega_{\mathrm{BS}}$ denote the feasible BS deployment region. A BS deployment solution is defined as

$$B = \{\mathbf{b}_1, \mathbf{b}_2, \ldots, \mathbf{b}_K\}, \quad \mathbf{b}_k \in \Omega_{\mathrm{BS}}, \tag{4}$$

where $K$ is the number of deployed BSs. At each UAV waypoint $\mathbf{s}$, the UAV is assumed to connect to the BS with the strongest received signal among all deployed BSs. Accordingly, the effective signal quality experienced by the UAV is defined as

$$Q(\mathbf{s}, B) = \max_{\mathbf{b}_k \in B} Q_k(\mathbf{s}), \tag{5}$$

where $Q_k(\mathbf{s})$ is the signal-to-noise ratio (SNR) at waypoint $\mathbf{s}$ provided by BS $\mathbf{b}_k$. The SNR value is obtained from the ray-tracing radio map as

$$Q_k(\mathbf{s}) = P_{\mathrm{EIRP}} + G_{\mathrm{ch}}(\mathbf{b}_k, \mathbf{s}) + G_{\mathrm{rx}} - P_{\mathrm{N}} - F_{\mathrm{N}}, \tag{6}$$

where $P_{\mathrm{EIRP}}$ is the equivalent isotropic radiated power, $G_{\mathrm{ch}}(\mathbf{b}_k, \mathbf{s})$ is the channel gain obtained by ray tracing, $G_{\mathrm{rx}}$ is the receiver antenna gain, $P_{\mathrm{N}}$ is the thermal noise power, and $F_{\mathrm{N}}$ is the noise figure.

The total flight length of all OD paths is defined as

$$L(\Pi) = \sum_{m=1}^{M_D} \sum_{n=1}^{N_m - 1} \|\mathbf{s}_{m,n+1} - \mathbf{s}_{m,n}\|_2 . \tag{7}$$

The joint design problem is formulated as

$$\begin{aligned} \min_{B,\Pi} \quad & J(B, \Pi) = L(\Pi) + \alpha |B| \\ \text{s.t.} \quad & \mathbf{s}_{m,n} \notin \Omega_{\mathrm{obs}}, \quad \forall m, n, \\ & Q(\mathbf{s}_{m,n}, B) \geq \gamma_{\mathrm{th}}, \quad \forall m, n, \\ & \mathbf{b}_k \in \Omega_{\mathrm{BS}}, \quad \forall \mathbf{b}_k \in B. \end{aligned} \tag{8}$$

Here, $\alpha$ converts the cost of deploying one BS into an equivalent path-length penalty, and $\gamma_{\mathrm{th}}$ is the minimum SNR threshold required for reliable communication.

## 4. Proposed Reciprocity-Guided Greedy Method

The optimization problem in Equation 8 is difficult because BS placement and flight corridor planning are strongly coupled. A BS layout determines the communication-feasible region, while the selected flight corridors indicate where communication coverage is actually needed. To address this coupling, we propose a reciprocity-guided iterative greedy method, as summarized in Algorithm 1.

**Algorithm 1** - Reciprocity-guided iterative greedy BS placement and path planning.

**Input:** Urban map, OD set $D$, feasible BS region $\Omega_{\mathrm{BS}}$, SNR threshold $\gamma_{\mathrm{th}}$, BS budget schedule $\{K_r\}_{r=1}^{R}$, waypoint sampling step, SNR margin $\Delta_{\mathrm{SNR}}$.
**Output:** Selected BS set $B^*$ and communication-aware path set $\Pi^*$.

1. Construct obstacle maps at the UAV altitude and BS height.
2. Plan initial communication-free paths $\Pi^{(0)}$ for all OD pairs using A*.
3. Set the current path set $\Pi_{\mathrm{cur}} \leftarrow \Pi^{(0)}$.
4. **For** each round $r = 1, 2, \ldots, R$ with BS budget $K_r$ **do**:
   4.1 Sample waypoint set $W^{(r)}$ from $\Pi_{\mathrm{cur}}$.
   4.2 Treat each sampled waypoint as a virtual transmitter and compute reciprocal radio maps over $\Omega_{\mathrm{BS}}$.
   4.3 Initialize selected BS set $B^{(r)} \leftarrow \emptyset$ and uncovered waypoint index set $U^{(r)} \leftarrow \{1, \ldots, N_W\}$.
   4.4 **While** $|B^{(r)}| < K_r$ and $U^{(r)} \neq \emptyset$ **do**:
      Select $\mathbf{b}^* = \arg\max_{\mathbf{b} \in \Omega_{\mathrm{BS}}} |C^{(r)}(\mathbf{b}) \cap U^{(r)}|$.
      Update $B^{(r)} \leftarrow B^{(r)} \cup \{\mathbf{b}^*\}$.
      Update $U^{(r)} \leftarrow U^{(r)} \setminus C^{(r)}(\mathbf{b}^*)$.
      Remove infeasible or already selected nearby BS candidates if necessary.
   4.5 Compute the forward SNR radio map generated by $B^{(r)}$.
   4.6 Mark cells with obstacles or SNR below $\gamma_{\mathrm{th}}$ as infeasible.
   4.7 Replan all OD paths using A* on the communication-feasible map.
   4.8 **If** all OD paths are found **then** update $\Pi_{\mathrm{cur}} \leftarrow \Pi^{(r)}$, $B^* \leftarrow B^{(r)}$, and $\Pi^* \leftarrow \Pi^{(r)}$.
5. **Return** $B^*$ and $\Pi^*$.

### 4.1 Reciprocity-Guided Greedy BS Selection

The algorithm starts from communication-free shortest paths, which are obtained by considering only the obstacle map and ignoring the SNR constraint. These initial paths provide the geometric lower bound of the flight distance and also indicate where communication support is most urgently needed. Let the current path set at iteration $r$ be denoted by $\Pi_{\mathrm{cur}}^{(r)}$. A waypoint set is sampled from these paths as

$$W^{(r)} = \{\mathbf{w}_1^{(r)}, \mathbf{w}_2^{(r)}, \ldots, \mathbf{w}_{N_W}^{(r)}\}, \tag{9}$$

where each waypoint represents a local communication demand point along the current UAM corridors.

The key step is to use these sampled waypoints to guide BS placement through channel reciprocity. Instead of evaluating a large number of BS candidates blindly in the forward direction, each sampled waypoint is temporarily treated as a virtual transmitter. For a waypoint $\mathbf{w}_i^{(r)}$ and a candidate BS location $\mathbf{b} \in \Omega_{\mathrm{BS}}$, the reciprocal SNR is denoted by

$$\widetilde{Q}_i^{(r)}(\mathbf{b}) = Q(\mathbf{b}, \{\mathbf{w}_i^{(r)}\}). \tag{10}$$

In a static propagation environment, the channel between $\mathbf{w}_i^{(r)}$ and $\mathbf{b}$ is approximately reciprocal. Therefore, a high value of $\widetilde{Q}_i^{(r)}(\mathbf{b})$ indicates that a BS deployed at $\mathbf{b}$ is likely to provide strong forward-link coverage to the UAV waypoint $\mathbf{w}_i^{(r)}$.

For each candidate BS location, its waypoint coverage set is defined as

$$C^{(r)}(\mathbf{b}) = \left\{ i \mid \widetilde{Q}_i^{(r)}(\mathbf{b}) \geq \gamma_{\mathrm{th}} + \Delta_{\mathrm{SNR}} \right\}, \tag{11}$$

where $\Delta_{\mathrm{SNR}}$ is an SNR margin used during BS selection. This margin makes the BS selection more conservative, because a candidate location is considered useful only when it can provide a signal level above the required threshold with additional robustness.

The BS selection in each round is then formulated as a greedy waypoint-covering process. Let $U^{(r)}$ denote the set of waypoint indices that have not yet been covered by the selected BSs. Starting from an empty BS set $B^{(r)}$, the algorithm repeatedly selects the candidate BS location that covers the largest number of currently uncovered waypoints:

$$\mathbf{b}^* = \arg\max_{\mathbf{b}\in\Omega_{\mathrm{BS}}} \left| C^{(r)}(\mathbf{b}) \cap U^{(r)} \right|. \tag{12}$$

After selecting $\mathbf{b}^*$, the BS set and uncovered waypoint set are updated as

$$B^{(r)} \leftarrow B^{(r)} \cup \{\mathbf{b}^*\}, \tag{13}$$

$$U^{(r)} \leftarrow U^{(r)} \setminus C^{(r)}(\mathbf{b}^*). \tag{14}$$

This process continues until the BS budget $K_r$ is reached or all sampled waypoints are covered. Through this design, the selected BSs are encouraged to support different portions of the current flight corridors rather than redundantly covering the same local region.

### 4.2 Communication-Constrained A* Path Planning

After the BS set $B^{(r)}$ is selected, a forward radio map is computed by placing transmitters at these BS locations. The communication-feasible flight region is then obtained by combining the obstacle map with the SNR map generated by $B^{(r)}$. A grid cell $\mathbf{s}$ is considered feasible only if it satisfies both the obstacle avoidance constraint and the communication constraint:

$$\mathbf{s} \notin \Omega_{\mathrm{obs}}, \quad Q(\mathbf{s}, B^{(r)}) \geq \gamma_{\mathrm{th}}. \tag{15}$$

Accordingly, the planning cost map is defined as

$$c^{(r)}(\mathbf{s}) = \begin{cases} 1, & \mathbf{s} \notin \Omega_{\mathrm{obs}} \text{ and } Q(\mathbf{s}, B^{(r)}) \geq \gamma_{\mathrm{th}}, \\ +\infty, & \text{otherwise.} \end{cases} \tag{16}$$

The A* planner then searches for the shortest path between each OD pair on this constrained cost map. Since cells with insufficient SNR or building obstacles are assigned infinite cost, the resulting path can only pass through regions that are both physically flyable and communication-feasible.

For each OD pair $(o_m, d_m)$, the replanned path is obtained as

$$\pi_m^{(r)} = \arg\min_{\pi_m : o_m \to d_m} \sum_{\mathbf{s}\in\pi_m} c^{(r)}(\mathbf{s}). \tag{17}$$

If no path can be found for any OD pair, the current BS layout is regarded as infeasible for the corridor network. Otherwise, the set of all replanned OD paths forms $\Pi^{(r)}$ and is used to guide the next reciprocity-based BS selection round.

## 5. Experiments

### 5.1 Simulation Setup

The experiments are conducted in a digital-twin urban scenario reconstructed from OpenStreetMap data. The selected area is Kwun Tong, Hong Kong, which contains dense buildings and irregular street layouts. This environment creates strong blockage and multipath effects, making it suitable for evaluating communication-aware UAM corridor planning.

Radio maps are generated using Sionna RT [19], a GPU-accelerated ray-tracing simulator. The main parameters are listed in Table 1. Four vertiports are considered, resulting in six OD pairs. The BS budget schedule is set to $10, 6, 5, 4, 3$.

Table 1 – Main simulation parameters.

| Parameter | Value |
|---|---|
| Map size | $1600\ \mathrm{m} \times 1400\ \mathrm{m}$ |
| Flight altitude | $50\ \mathrm{m}$ |
| BS height | $10\ \mathrm{m}$ |
| Number of vertiports | 4 |
| Number of OD pairs | 6 |
| Carrier frequency | $39\ \mathrm{GHz}$ |
| Bandwidth | $400\ \mathrm{MHz}$ |
| EIRP $P_{\mathrm{EIRP}}$ | $60\ \mathrm{dBm}$ |
| Receiver gain $G_{\mathrm{rx}}$ | $8\ \mathrm{dB}$ |
| Noise figure $F_{\mathrm{N}}$ | $5\ \mathrm{dB}$ |
| SNR threshold $\gamma_{\mathrm{th}}$ | $20\ \mathrm{dB}$ |
| SNR margin $\Delta_{\mathrm{SNR}}$ | $5\ \mathrm{dB}$ |
| Ray-tracing depth | 3 |
| Waypoint sampling step | 35 |
| BS budget schedule $\{K_r\}$ | $10, 6, 5, 4, 3$ |
| Cost weight $\alpha$ | 500 |

### 5.2 Baseline and Evaluation Metrics

The proposed method is compared with a conventional wide-area coverage baseline. The baseline uniformly samples candidate deployment points from the obstacle-free region and selects BSs according to their coverage over the sampled area. This strategy represents a conventional cellular deployment objective that attempts to cover the service region rather than focusing on UAM corridors.

For fairness, both methods use the same ray-tracing simulator, the same SNR threshold, and the same communication-aware A* path planner for final verification.

The main evaluation metrics are:

- **Total path length:** the sum of the lengths of all feasible OD paths $L(\Pi)$.
- **BS count:** the number of deployed BSs $|B|$.
- **Objective value:** $J = L(\Pi) + \alpha|B|$.

## 6. Results and Discussion

### 6.1 Iterative Reduction of BS Count

The proposed method starts with a relatively large BS budget and gradually reduces the number of BSs. At each round, the current flight corridors are used to guide the next BS placement through reciprocal radio maps. This iterative process allows the selected BSs to remain aligned with the actual communication demand of the UAM corridors.

Figure 1 shows the iterative result from the proposed method. The communication-free lower bound has a total length of $6277.9\ \mathrm{m}$ but does not enforce the SNR constraint. With communication constraints, the proposed method obtains feasible paths of $6344.0\ \mathrm{m}$, $6454.6\ \mathrm{m}$, $6457.9\ \mathrm{m}$, $6667.9\ \mathrm{m}$, and $6693.1\ \mathrm{m}$ for BS budgets of 10, 6, 5, 4, and 3, respectively. This trend shows that the path length increases moderately as fewer BSs are deployed.

### 6.2 Comparison with Wide-Area Coverage Baseline

Table 2 compares the proposed method with the wide-area coverage baseline. The baseline deploys BSs according to general area coverage, whereas the proposed method selects BSs according to

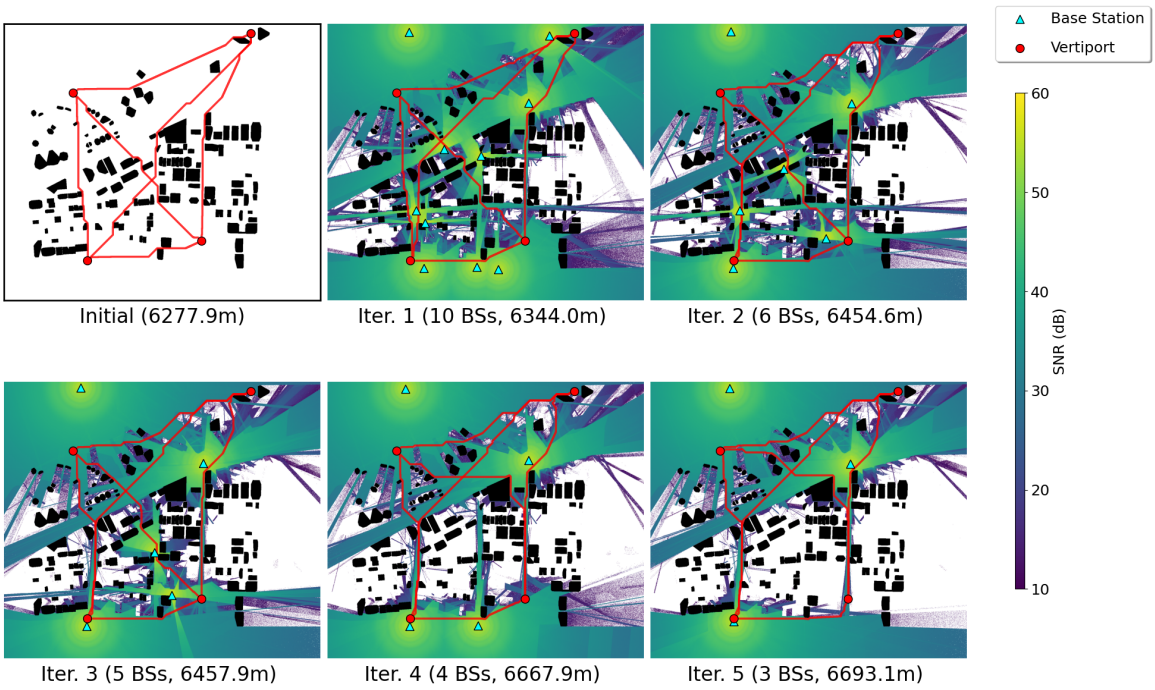



Figure 1 – Evolution of communication-aware flight corridors during the iterative BS reduction process.

corridor-related reciprocal coverage. As a result, the proposed method achieves a lower objective value while maintaining feasible communication-aware paths.

Table 2 – Comparison between the proposed method and the wide-area coverage baseline.

| Method | BS count | Path length [m] | Objective $J$ |
|---|---|---|---|
| Communication-free lower bound | – | 6277.9 | – |
| Wide-area coverage baseline | 4 | 7211.0 | 9211.0 |
| Proposed method | 3 | 6693.1 | 8193.1 |

The communication-free lower bound ignores the SNR constraint and therefore gives the shortest possible paths. However, these paths may pass through communication blind spots. The wide-area coverage baseline improves connectivity but may deploy BSs in locations that are not directly useful for the flight corridors. In contrast, the proposed method concentrates infrastructure around path-relevant regions. Compared with the baseline, the proposed method reduces the objective value by approximately $11.1\%$ while using one fewer BS.

## 6.3 Sensitivity to Cost Weight

The cost weight $\alpha$ determines the relative importance of infrastructure deployment cost and flight distance in the objective function. A smaller $\alpha$ indicates that deploying additional BSs is relatively inexpensive, so the optimization tends to prefer more BSs to reduce the communication-constrained path length. In contrast, a larger $\alpha$ assigns a higher penalty to each deployed BS and therefore favors solutions with fewer BSs, even if the resulting paths become slightly longer.

For each tested BS budget $K$, let $B_K$ denote the selected BS set with $|B_K| = K$, and let $\Pi_K$ denote the corresponding communication-constrained path set. The objective value under this BS budget is computed using the same objective function as in Equation 8:

$$J(B_K, \Pi_K) = L(\Pi_K) + \alpha |B_K| = L(\Pi_K) + \alpha K. \tag{18}$$

For compact notation, we write

$$J_K(\alpha) = L_K + \alpha K, \tag{19}$$

where $L_K = L(\Pi_K)$ denotes the total communication-constrained path length obtained with $K$ BSs. Based on the iterative results shown in Figure 1, the tested path lengths are

$$\begin{aligned} L_{10} &= 6344.0, \\ L_6 &= 6454.6, \\ L_5 &= 6457.9, \\ L_4 &= 6667.9, \\ L_3 &= 6693.1. \end{aligned} \tag{20}$$

The preferred BS budget under a given cost weight is therefore selected by

$$K^*(\alpha) = \arg \min_{K \in \{3,4,5,6,10\}} J_K(\alpha). \tag{21}$$

Figure 2 shows the objective value of each tested BS budget as a function of $\alpha$. The black curve represents the lower envelope of all candidate solutions and therefore indicates the optimal BS budget under each cost weight. As $\alpha$ increases, the optimal point moves from infrastructure-rich solutions to infrastructure-saving solutions. This illustrates that the proposed framework does not prescribe a fixed BS number; instead, it provides a cost-aware selection rule according to the relative price of infrastructure and flight distance.

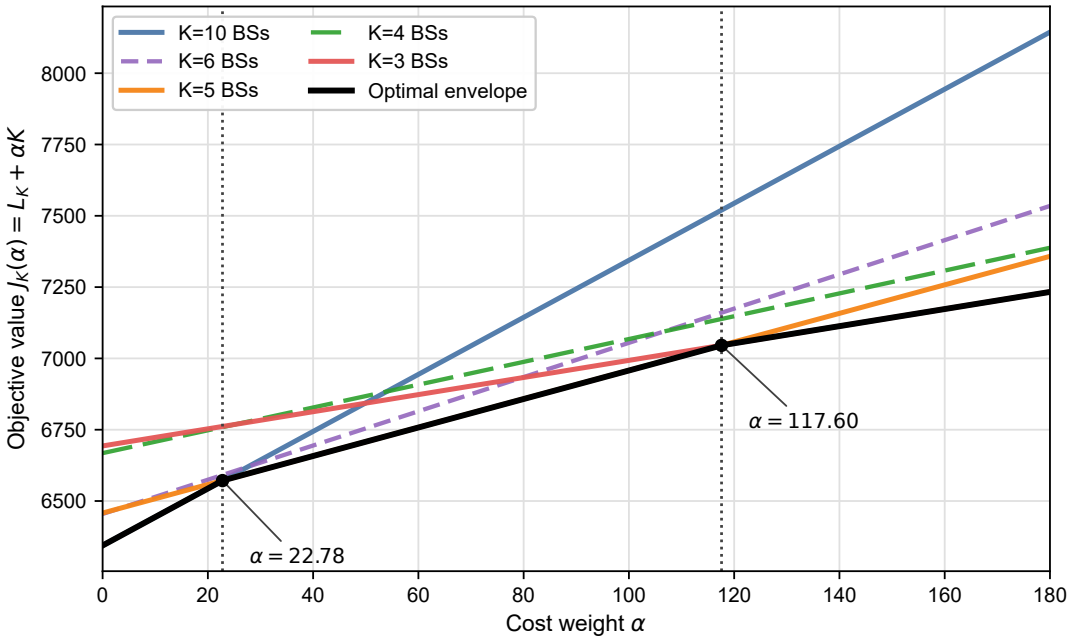



Figure 2 – Sensitivity of the optimal BS budget to the cost weight $\alpha$.

The breakpoints of $\alpha$ can be obtained by comparing the objective values of different BS budgets. In this experiment, only the 10-BS, 5-BS, and 3-BS solutions appear on the lower envelope of the cost-distance trade-off. The corresponding transition points are

$$\alpha_{10,5} = \frac{L_5 - L_{10}}{10 - 5} = 22.78, \tag{22}$$

and

$$\alpha_{5,3} = \frac{L_3 - L_5}{5 - 3} = 117.60. \tag{23}$$

Thus, the optimal BS budget changes with $\alpha$ as summarized in Table 3. When $\alpha$ is small, the 10-BS solution is preferred because its shorter path length compensates for the additional infrastructure. For medium values of $\alpha$, the 5-BS solution provides the best balance between deployment cost and path length. When $\alpha$ is large, the 3-BS solution becomes optimal because the saving in infrastructure cost dominates the moderate increase in path length.

Table 3 – Optimal BS budget under different cost weights.

| Cost weight range | Optimal BS budget |
|---|---|
| $0 \leq \alpha < 22.78$ | 10 BSs |
| $\alpha = 22.78$ | 10 or 5 BSs |
| $22.78 < \alpha < 117.60$ | 5 BSs |
| $\alpha = 117.60$ | 5 or 3 BSs |
| $\alpha > 117.60$ | 3 BSs |

### 6.4 Discussion

The proposed method does not attempt to cover the entire map. Instead, it uses the current corridors to identify where coverage is needed and places BSs that are useful for those corridors. This design is especially beneficial in dense urban environments, where many areas are irrelevant to the flight mission or are blocked by buildings.

The method also has limitations. Since the BS selection is greedy, it does not guarantee global optimality. In addition, the radio maps depend on the accuracy of the geometric model and the ray-tracing settings. Future learning-guided search methods may further improve the deployment quality, but the proposed method provides a simple and interpretable baseline for reciprocity-guided corridor-infrastructure co-design.

## 7. Conclusion

This paper studied the joint optimization of BS placement and flight corridor planning for low-altitude UAM in dense urban environments. A reciprocity-guided iterative greedy method was proposed to exploit the path-centric nature of UAM communication demand. By treating sampled UAV waypoints as virtual transmitters, the method identifies promising BS locations through reciprocal radio maps and verifies the resulting deployment using forward ray-tracing radio maps.

Simulation results in a digital-twin urban scenario show that the proposed method can reduce the deployment-and-flight objective compared with a conventional wide-area coverage baseline. Future work will extend the method to learning-guided search, multi-altitude corridors, dynamic blockage, and multi-UAV traffic management.

## 8. Contact Author Email Address

mailto: yhedz@connect.ust.hk

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