

## CHAPTER V

### CONCLUSIONS

In this chapter, we present conclusions about the two-dimensional mobility model for studying wireless communication and present a few open problems. Also, we suggest the adaptation and the use of this work in the future.

#### 5.1 Summary

We have shown the complexities of the two decision problems UCP and SRP stated in [1] in both two and three dimensional cases. We have shown that the two decision problems related to the mobility model are in fact in  $P$ . This directly implies that both can be solved efficiently in polynomial time. Indeed, our algorithms run in  $O(m^2)$ . We have also proved that our algorithms to solve the two stated problems in two dimensions are *time-optimal* by providing a lower bound  $\Omega(m^2)$  for the two decision problems. We know that this lower bound is an *asymptotically tight* lower bound for the two problems in a two-dimensional grid. However, we have yet to show whether or not this lower bound is also tight in the case of a three-dimensional grid. In addition, we have also proved the intractability of a variety of APLP in two dimensional cases. There are also other decision problems in [1] that await solutions to their level of the complexity. We are also interested in determining the parallel complexity [12] of these decision problems. These open problems will be our future endeavors.

#### 5.2 Open Problems

In this section a few interesting research problems, proposed by Greenlaw and Kantabutra [1], related to the mobility model are given. We begin with several key decision problems.

Access Point Location Problem With Equal Diameters

INSTANCE : A mobility model  $(S, D, U, L, R, V, C, O)$ , two designated users  $u_a$  and  $u_b$  from  $U$ , an access point diameter  $d$ , and a natural number  $k$ .

QUESTION : Can users  $u_a$  and  $u_b$  communicate throughout the duration of the model if  $k$  or fewer access points of diameter  $d$  are placed appropriately in the grid?

Access Point Location Problem With Varying Diameters

INSTANCE : A mobility model  $(S, D, U, L, R, V, C, O)$ , two designated users  $u_a$  and  $u_b$  from  $U$ , a set of corresponding access point diameters  $\{d_1, d_2, \dots, d_k\}$ , and a natural number  $k$ .

QUESTION : Can users  $u_a$  and  $u_b$  communicate throughout the duration of the model if  $k$  or fewer access points of diameter  $d$  are placed appropriately in the grid?

Access Point Placement Problem

INSTANCE : Two mobility models  $M = (S, D, U = \{u_1, u_2\}, L, R, V, C, O)$  and  $M' = (S, D, U = \{u_1, u_2\}, L, R', V', C', O')$ .

QUESTION : Can  $u_1$  and  $u_2$  communicate for more steps in model  $M$  than they can in model  $M'$ ?

Obstacle Removal Problem

INSTANCE : A mobility model  $(S, D, U, L, R, V, C, O)$ , two designated users  $u_a$  and  $u_b$  from  $U$ , and a natural number  $k$ .

QUESTION : Can  $u_a$  and  $u_b$  communicate throughout the duration of the model if  $k$  or fewer obstacles are removed?

### K-Pairs Communication Problems

INSTANCE : A mobility model  $(S, D, U, L, R, V, C, O)$ ,  $k$  pairs of users  $\{u_1, u'_1\}, \{u_2, u'_2\}, \dots, \{u_k, u'_k\}$ .

QUESTION : Can all  $k$  pairs of users simultaneously communicate throughout the duration of the model (i.e., each user pair must not share an access point)?

### 5.3 Suggestions

Some suggestions for developing and using this work in the future are given.

1. Find time complexities for the open problems in the three-dimensional grid.
2. Find time complexities of decision problems that are still open or have not been presented in this work. If some of these problems are *NP*-complete, we can use traditional approaches of randomized and approximation algorithms to obtain efficient partial solutions to them. If some of the problems are in *P*, we can try to find the most-efficient algorithms for these problems.
3. Find time complexities for the open problems both in serial and parallel settings.
4. Adopt these problems in real life situations, such as in the case of natural disasters and military use.