

# Chapter 17

## Nature-Inspired– Algorithms–Based Cellular Location Management: Scope and Applications

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### ABSTRACT

*Nature-Inspired algorithms have gained relevance particularly for solving complex optimization problems in engineering domain. An overview of implementation modeling of the established algorithms to newly developed algorithms is outlined. Mobile location management has vital importance in wireless cellular communication and can be viewed as an optimization problem. It has two aspects: location update and paging where the objective is to reduce the overall cost incurred corresponding to these two operations. The potential application of the Nature-Inspired algorithms to mobile location management is studied. Many such algorithms are recently being explored along with incremental modifications to the existing techniques. Finally, analysis and insights highlight the further scopes of the Nature-Inspired algorithms to mobile location management application.*

### 1. MISSION AND CONCERNS

The purpose of this chapter is to introduce the existing as well as recently developed Nature-Inspired algorithms with their implementation details and flowcharts. This chapter also provides a survey analysis of Nature-Inspired algorithms for cost optimization in mobile location management (MLM) problem and

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their further potential scope of application. The objective of this work is to introduce the importance of these algorithms for solving the real time applications and also provides initial food for thought in terms of the scope of these algorithms in MLM. In recent years, these metaheuristic nature-inspired optimization algorithms have witnessed a lot of attention in this domain except the newly developed ones whose applicability still remains unexplored. The various sections of this chapter are divided as: Introduction and background, problem formulation and modelling mobile location management as optimization problem and MLM schemes. Subsequently nature-inspired algorithms are explored in general context. Then based on the location management applications and scope of the algorithms, we provide insights on the potential applications of recently developed nature-inspired algorithms for future research directions.

## **2. INTRODUCTION AND BACKGROUND**

The nature-inspired algorithms owe their significance due to the ability to adapt to the changing behavior of the objective function and automatic adjustment from exploration to exploitation to find the global optimal solution and at the same time fine-tuning the control parameters to increase the convergence speed and decrease the computational cost. There is extensive use of these algorithms principally due to their simplicity, easy implementation and diverse solutions (Yang 2012b). Recently, the wireless communication technology has undergone tremendous growth and since the numbers of mobile users are rising rapidly, the mobile location management (MLM) has captured the attention of the researchers which is a key issue in mobile computing. The importance of cellular network lies in managing the traffic efficiently and effectively. Since metaheuristic techniques allow for a variety of possibilities for solving a problem, hence it is employed in optimizing location management cost. This cost must be optimized to minimize lag and bloat in the network and increase profit and cellular capacity. This may be done by resorting to nature-inspired algorithms which are usually robust and natural to implement (Alba et al. 2008).

Location Management is the dynamic tracking of current location of mobile users in a cellular network. It also deals with minimizing cost and overhead associated with the process. It broadly consists of two processes: Location update and Paging (Wong and Leung 2009). In some research work, Location update is also referred to as 'Registration' or 'Location Registration', whereas Paging is also referred to as 'Location Lookup' or 'Search'. Location update is performed by the user equipment which informs the network of the user's current location. Paging is performed by the base station which polls a group of cells to determine the precise location of the user so that an incoming call can be diverted to it without much delay. There is utmost need for efficient cellular network design such that the cost and delay involved in location mobility management is optimized. Thus, many schemes have been proposed for solving this issue which is discussed in detail in section 4, the principal ones being location area (LA) scheme and reporting cell planning (RCP) strategy which differ in subtle ways. The LA refers to a cluster of cells in a cellular network and the location update is performed only when the mobile terminal (MT) crosses the boundary of one LA to another and the paging is also limited to that LA where the MT currently resides. LA is a group of cells within which no registration occurs, whereas Reporting Cell is that only within which registration occurs.

Thus, a network with  $N$  cells can be divided into several disjoint location areas such that:

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