Chapter 10
Survey on Multi-Objective Routing Optimization in Ad Hoc Networks: Challenges for Green Technology

Bachir Bouamoud
University of Mohammed V Rabat, Morocco

Ahmed Habbani
University of Mohammed V Rabat, Morocco

ABSTRACT
The chapter presents a survey on multi-objective routing issues to solve the problem of optimal path according to resources requirement or QoS preferences especially energy conservation. In the present work, we draw the set of uniformly and not uniformly improvable routing objective, highlight dependencies between them and what are the effects of that on establishing the objectives functions and how it can contribute to energy conservation and state of art of different multi-objective routing problem resolution techniques applied in ad hoc network context. Many methods developed with different answers to these questions are present in the literature; some of them are discussed here.

INTRODUCTION
At present most of the Ad hoc network routing protocol only has a single optimization objective. Ad hoc networks paths selection lacks a multi-objective approach evaluation. Where traditional network mainly considers the shortest route which does not perform efficiently from energy saving side.

The basic task of multi-objective routing is to find a route in the network which has sufficient resources to optimize some network objectives and satisfy multiple constrains. While in some decision contexts, the inclusion of a single criterion is insufficient. Indeed in several fields the multi-objective or even multi-criteria problem are present, namely, when elaborating production plan in a factory, it has to deal with economical, marketing, social and environmental constrains or when organizing recruitment session the...
suitable candidate is the one who has the best background, skills and motivation. In the context of Ad hoc network, a perfect routing performance optimization is whose objectives are multi-target including latency, delay jitter, security vulnerability, and data packet loss rate, dealing with resource constraints e.g. bandwidth /energy and contributing to energy efficiency.

The usage of optimization in routing field is getting larger every day as the computational capabilities devices are increasing. Today calculations could be performed in a fraction of the time it took just a couple of years ago. Therefore, the applications for numerical optimization have increased dramatically.

In a natural way, the great part of the routing solutions is and will always be intuitive; however analytical techniques as well as numerical optimization could be of great value and can permit vast improvement. As for routing problems these one are generally characterized by the presence of many often conflicting and incommensurable objectives. This fact rises up the issue about how different objectives should be combined to yield a final solution. There is also the question on how to search for an optimal solution to the path selection problem.

There are many different ad-hoc routing protocols, proposed in the literature, to date. Generally, these can be categorized by the way they maintain routing information. For example, routing protocols, which maintain routing information for each node on the network, at all times, are categorized as proactive, while protocols which discover routing information only when it is required, are categorized as reactive. The reader may refer to (Boukerche et al., 2011) for an extensive survey on routing protocols and their functions.

The common ground, that these approaches share, is the mechanism for deciding upon optimal routes, and penury redundant paths support. The hop-counting mechanism, which is typically employed for optimal route determination, can significantly reduce the reliability, and, performance of the network. With this, a route is represented by the number of intermediate nodes, which needs to be traversed to reach the destination. For example, a route with three intermediate nodes is considered to be fitter than a route with more than three. However, this is not always true, especially with the vast diversity of performance capabilities of mobile devices. In addition, different routing scenarios impose different requirements, and thus a path may be suitable for a certain objective but unsuitable for another. The determination of the optimal route is a complex task, and requires research into the best metrics, such as memory capacity, network performance, processing capabilities, and so on, which should also be appraised to the routing objective that the route is seeking to accomplish.

This paper surveys the mean objectives of routing in ad hoc networks, overviews methods for resolving optimization problem and presents different ways of developing hybrids among them. First we present the background and motivation of conducting multi-objectives routing optimization in context of ad hoc networks, after that we review the main formulation of such problem. Another part of the paper highlights dependencies between different objectives and what are the effects of that on establishing the objectives functions and how it can contribute to energy conservation. Many methods developed with different answers to these questions are present in the literature; some of them are discussed here.

**BACKGROUND**

Intuitively the answer of the question How to select a route that match with multiple requirement of network performance, is to formulate it as a multi-objective (MO) optimization problem which is also an optimization problem that involves multiple objective functions. Therefore given a source and a