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Smart Perception and Autonomic Optimization: A Novel Bio-inspired Hybrid Routing Protocol for MANETs

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Abstract

Routing in mobile ad hoc networks (MANETs) is an extremely challenging issue due to the features of MANETs. In this paper, we present a novel bio-inspired hybrid trusted routing protocol (B-iHTRP) based on trusted assessment, ant colony optimization (ACO) and physarum autonomic optimization (PAO). Firstly, we introduce the cross-layer perception into ACO to obtain perceptive ants. Then, we divide the network into multiple zones. Within each zone, the route table is maintained proactively by the perceptive ants which can sense concerned parameters. Among zones, the perceptive ants are sent to reactively find routes to destinations while sensing concerned parameters. Secondly, B-iHTRP uses PAO to select the optimal one from the found routes and autonomically optimize the local routes during the course of multi-zone communication sessions. Simulation results show that B-iHTRP can achieve better performance comparing with existing state-of-the-art algorithms.

Keywords: MANETs, Bio-inspired, Routing Protocol, ACO, PAO

1 Introduction

MANETs are autonomous wireless communication networks that appear often in self-organized mobile application scenarios, where mobile nodes can communicate with each other via equipped wireless interfaces without relying on any infrastructures [1]. When temporary communication system is needed in a field with no infrastructure existed, MANETs can be applied easily, e.g., earthquake-stricken area and wild large events venue [2]. Any two nodes located within the other side's signal range can communicate directly; otherwise, they can communicate via other nodes. Therefore, every node performs functions of route and client at the same time [3].

Due to the features of MANETs, the design of the routing algorithms should incorporate many factors, e.g., dynamical changes of network topology, extra overhead, node's trust and energy saving. For node's trust, since the security of multi-hop communication depends primarily on the reliability of the nodes involved in the route, it is important that the routing protocols know the reliability of the involved nodes. Traditional MANET routing protocols assume that all nodes work in a benevolent manner, which may lead to MANETs being vulnerable against malicious attacks when selfish and malicious nodes are present. Routing protocols, data, battery power and bandwidth are the common targets of the attacks [3]. Researches have proven that forward selfish behavior will affect the network performance seriously; for example, a small portion of selfish nodes (10%-40%) will lead to a significant decrease (16%-32%) in the network performance [4]. For link quality, since weak link quality (e.g., signal strength) will lead to data retransmission in medium access layer which increases route delay, it is a factor of extreme importance for designing routing protocols in MANETs [5]. In summary, there are multiple factors affecting route efficiency, such as route hops, link load and node reliability, which make the design of an efficient routing algorithm extremely challenging.

Since the early 1980s, a great number of researchers devote themselves to enhancing the efficiency of MANETs' routing algorithms [6]. Based on the time of route discovery triggered, the existing routing algorithms can be classified into three categories—proactive routing, reactive routing and hybrid routing [7]. In proactive routing, each node broadcasts its route table periodically to its neighbors such that every node has a global view of the network, e.g., PSR [8] and FSR [9]. In reactive routing, nodes establish routes only on demand, e.g., AODV [10] and CAODV [11]. Reactive routing performs route discovery at a lower extra overhead by having to suffer a longer response time which, in proactive routing, is totally converse. As a result, hybrid routing is proposed to combine the advantages of the two types of routing. Generally, hybrid routing divides a network into different regions and, then, proactive routing is adopted within a region and reactive routing among regions, e.g., ZRP [12] and HOPNET [7].

Routing trust and efficiency attract some researchers' attention in recent years, which are a pair of conflicting metrics in most cases. Overemphasis on routing trust will increase control overhead and reduce routing efficiency, whilst overemphasis on routing efficiency will result in ignoring the other aspects (e.g., node trust), which may be reacting to routing efficiency. Some conventional methods have been applied to