A Novel Dynamic Noise-Dependent Probabilistic Algorithm for Route Discovery in MANETs

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ABSTRACT
In mobile ad hoc networks (MANETs), broadcasting is widely used in route discovery and other network services. The most widely used broadcasting algorithm is simple flooding, which aggravates a high number of redundant packet retransmissions, causing contention and collisions. Proper use of dynamic probabilistic algorithm significantly reduces the number of retransmissions, which reduces the chance of contention and collisions. In current dynamic probabilistic algorithm, the retransmission probability \( p \) is formulated as a linear/non-linear function of a single variable, the number of first-hop neighbors \( k \). However, such algorithm suffers in the presence of noise due to increasing packet-loss. In this paper, the authors propose a new dynamic probabilistic algorithm in which \( p \) is determined locally by the retransmitting nodes considering both \( k \) and the noise-level. This algorithm is referred to as the dynamic noise-dependent probabilistic (DNDP) algorithm. The performance of the DNDP algorithm is evaluated through simulations using the MANET simulator (MANSim). The simulation results show that the DNDP algorithm presents higher network reachability than the dynamic probabilistic algorithm at a reasonable increase in the number of retransmissions for a wide range of noise-level. The effects of nodes densities and nodes speeds on the performance of the DNDP algorithm are also investigated.

Keywords: Flooding Optimization Algorithms, MANETs, Probabilistic Algorithm, Route Discovery, Routing Protocols

INTRODUCTION
A MANET is defined as a collection of low-power wireless mobile nodes forming a temporary network without the aid of any established infrastructure or centralized ad-

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routing (AODV) (Perkins & Royer, 2000), the
dynamic source routing (DSR) (Johnson &
Maltz, 1995), and the location-aided routing
(LAR) (Ko & Vaidya, 2000). DRPs consist of
two major phases: (i) route discovery in which
a route between source and destination nodes
is established for the first time, and (ii) route
maintenance in which the route is maintained;
and if it is broken for any reason, then the
source node either finds other known route on
its routing table or initiates new route discovery
procedure (Royer & Toh, 1999). The cost of
information exchange during route discovery
is higher than the cost of point-to-point data
forwarding after the route is established (Rah-
man et al., 2004).

Broadcasting is a fundamental communi-
cation primitive for route discovery in DRPs
in MANETs. One of the earliest broadcast
mechanisms proposed in the literature is
simple flooding, which is also called pure or
blind flooding. Although it is simple and reli-
able, simple flooding is costly where it costs
n retransmissions in a network of n reachable
nodes. Simple flooding in wireless networks
results in serious redundancy, contention, and
collisions; such a scenario has often been re-
ferred to as the broadcast storm problem (BSP)
(Tseng et al., 2002).

To eliminate the effects of the BSP dur-
ding route discovery in MANETs, a variety of
flooding optimization techniques have been
developed to reduce the number of retransmis-
sion for the route request (RREQ) messages.
As the number of retransmissions required
for broadcasting is decreased, the bandwidth
is saved and contention and node power con-
sumption are reduced, and this will improve
the overall network performance. Examples of
flooding optimization techniques algorithms:
probabilistic (Bani-Yassin et al., 2006), LAR
(Ko & Vaidya, 2000), multipoint relaying (Al-
Bahadili & Jaradat, 2010; Qayyum et al., 2002),
counter-based and distance-based (Tseng et al.,
2002), cluster-based (Bettstetter, 2004).

In this paper, our main concern is the prob-
abilistic flooding algorithm. In this algorithm,
each intermediate node (any node on the network
except the source and the destination) is assigned
a certain \( p_i \). There are two approaches that can
be used to set a satisfactory \( p_i \) for intermediate
nodes on the network: static and dynamic. In
the former, a pre-determined \( p_i \) is set for each
node on the networks, while for the later, each
node locally and dynamically calculates its \( p_i \)
according to \( k \) and it can be expressed as:
\( p_i = f(k) \),
where \( f(k) \) is a linear/non-linear function of \( k \).

In reality, communication channels in
MANETs are unreliable due to many types of
impairments, such as: signal attenuation, free
space loss, noise, atmospheric absorption, etc.
In addition, in MANETs, error in reception may
occur due to rapidly changing topologies that
are caused by nodes movement. All of these
impairments and changing topologies may
cause an error in reception and are represented
by a generic name, noise. The effect of noise in
MANET can be simulated through introducing
a probability factor that is the probability of
reception \( (p_c) \), and then the effect of noise can
be determined randomly by generating a random
number \( \xi \) (Al-Bahadili & Jaradat, 2007). If \( \xi < p_c \),
then the packets is successfully delivered to the
receiving node, otherwise, it is undelivered.

It has been demonstrated that the perfor-
mance of probabilistic algorithm is severely
suffered in presence of noise (Al-Bahadili &
Kaabneh, 2010). Due to the fact that presence
of noise increases packet-loss rate in the network
or in other words it decreases \( p_c \) of a RREQ
packet by neighboring nodes and consequently
the destination node.

In order to enhance the performance of
the probabilistic algorithm in noisy MANETs,
we believe it is necessary to accommodate the
inevitable presence of noise in a MANET en-
vironment. In this paper, we developed a new
dynamic probabilistic route discovery algorithm
in which \( p_i \) is calculated locally considering both
\( k \) and \( p_i \), i.e., \( p_i = f(k, p_i) \); and the new algorithm
is referred to as the dynamic noise-dependent
probabilistic (DNDP) algorithm. In this algo-
rythm, the nodes dynamically adjust their \( p_i \) for
probabilistic flooding based on local network
topology information and noise-level. In par-
icular, we developed an efficient and effective
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