

A DHCP-based IP address autoconfiguration for MANETs

Carlos J. Bernardos and María Calderón

Dpto. Ingeniería Telemática
Universidad Carlos III de Madrid
Avda. Universidad, 30
28911 Leganés, Spain
`{cjbc, maria}@it.uc3m.es`

Abstract. Mobile Ad hoc Networks (MANETs) are expected to become more and more important in the upcoming years, playing a significant role in 4G networks. In order to enable the deployment of IP services in such networks, IP address autoconfiguration mechanisms are required. Although the ad hoc topic has been a very intense research area, with a plethora of published papers about routing, there is a lack of proposals of address autoconfiguration with enough support from the technical community. This paper presents a mechanism suited for MANETs connected to the Internet, reusing existing and widely deployed address autoconfiguration protocols, such as DHCPv6 and Router Advertisements.

1 Introduction

Users' demands are driving the Internet to evolve from a wired network that could only be accessed from fixed locations to a ubiquitous one, where the number of mobile users is continuously increasing (some authors [1] expect this number soon to exceed that of fixed-line Internet users). Such a demand of mobility and the challenge of deploying wireless access networks without *dead zones* (areas without coverage), caused alternatives to infrastructure-based networks to appear. One of these alternatives is what has been called Mobile Ad hoc Networks (MANETs). A MANET is a group of wireless mobile devices that cooperate together to form an IP network. This network does not require any infrastructure to work, since in a MANET users' devices are the network, so a node communicates not only directly with nodes within its wireless coverage, but also with others using a multi-hop route through other MANET nodes. To enable that multi-hop connectivity, several routing protocols have been proposed, some of them within the IETF¹ such as AODV [2], OLSR [3] and DSR [4].

In order to enable MANETs to support IP services, every node of a MANET should be configured at least with an IP address and a default gateway. However, there is no standard mechanism to provide MANET nodes with IP addresses (since existing IP configuration protocols [5] for traditional infrastructure-based networks cannot be used),

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¹ <http://www.ietf.org/>

thus requiring nodes to be configured *a priori* and avoiding ad hoc networks to be spontaneously created.

In this paper we present a centralised, but fault-tolerant, dynamic node configuration protocol, aimed at providing IP prefixes to nodes in a MANET. These prefixes are required to be unique globally. Providing prefixes instead of addresses presents some interesting advantages that will be described later in the paper.

The solution described in this paper is aimed for scenarios with the following characteristics: *connected* MANETs (i.e., ad hoc networks that are connected to the Internet through an Access Router deployed in an access network), *IPv6 addressing* (since IPv4 addressing is very limited), *cooperative* and *non permanent* environment, *quasi-dynamic* [6] MANETs (networks that are composed of nodes that does not move fast and continuously) and *non ad hoc access networks* (that is, ad hoc support is not required in the access network) with *prefix delegation* support.

The paper is organised as follows. In Section 2 we briefly present a classification of existing IP address autoconfiguration proposals for MANET. The proposed solution is shortly described in Section 3. Finally, Section 4 concludes the paper.

2 Related Work

The IETF has recently created a new working group, called AUTOCONF, to standardise mechanisms to be used by ad hoc nodes for configuring unique local and/or globally routable IPv6 addresses. There already exist quite a lot of existing proposals for IP address auto-configuration, that may be classified into two different categories: conflict-detection and conflict-free allocation. Ref. [7] presents a more detailed, but still summarised, survey of existing mechanisms for address auto-configuration in MANETs.

Conflict-detection allocation solutions are based on picking an IP address from a pool of addresses, configuring it as tentative address, checking the address uniqueness and requesting for approval from all the nodes of the network. In case of conflict (e.g., the address has been already configured by another node), the node should pick a new address and repeat the procedure (sort-of "trial and error" method).

Conflict-free allocation mechanisms assume that the addresses that are delegated are not being used by any node in the network. This can be achieved, for example, by ensuring that the nodes that participate in the delegation have disjoint address pools. In this way, there is no need of performing Duplicate Address Detection (DAD).

3 Solution Description

The core part of the protocol is the distribution of addresses among the nodes that are part of the MANET. The first step is obtaining a global IPv6 prefix to be shared in the MANET. This task is done by the first dual interface (a node that has interfaces with and without ad hoc support) node (hereafter called *initiator*) that falls into the radio coverage of an access network, using DHCPv6 (see Fig. 1). The size of the requested prefix should be big enough to be capable of delegating a prefix to every node joining the MANET. This obviously depends on the scenario, but we consider a /48 as a feasible default value [8], since it allows $2^{16} = 65536$ prefixes.

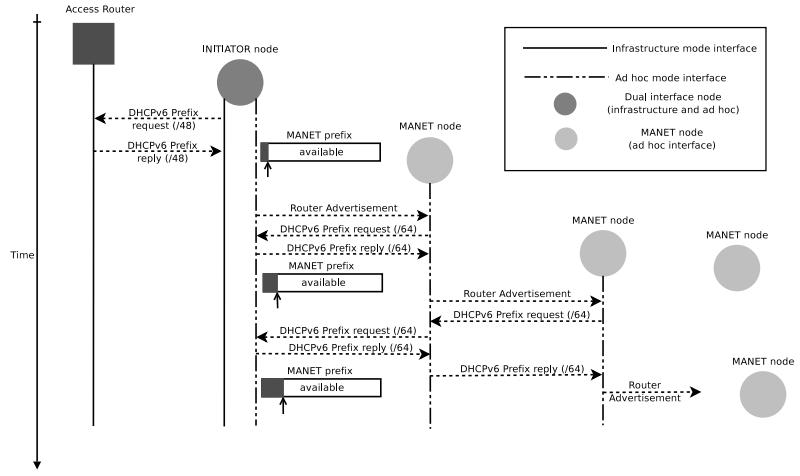


Fig. 1. Prefix auto-configuration signalling

The initiator node gets from the MANET prefix a /64 prefix for itself and starts sending Router Advertisements (RAs) through its ad hoc interface. Each RA contains a new option (MANET DHCP Prefix Delegation Information) that indicates to the receivers that the sender of the RA is able to delegate prefixes using DHCPv6. The inclusion of this option enables a MANET network to have nodes with different capabilities: with and without supporting our mechanism, thus making easier the interoperability and co-existence of different mechanisms in a MANET.

Receivers of these RAs, that is, new arriving nodes, may then configure an IPv6 address from the prefix contained in the RA (i.e., performing normal IPv6 stateless address auto-configuration [5]). These nodes may then request an IPv6 prefix for themselves, using DHCPv6. The initiator node delegates each of them a /64 prefix, keeping track of how many /64 prefixes from the MANET prefix are still available for distribution.

These MANET nodes configure their interfaces with addresses from the prefix they have just obtained and start sending RAs containing this prefix. Besides, if the nodes support our mechanism, they also include a MANET DHCP Prefix Delegation Information option. This enables other nodes that are within the radio coverage of these MANET nodes to obtain IPv6 addresses and request IPv6 prefixes.

When a MANET node, other than the initiator node, receives a DHCPv6 prefix request, it generates a new request and sends it to one node capable of delegating prefixes (it knows which neighbours are capable of delegating prefixes from the information contained in the received RAs). In this way requests are recursively generated until they reach the initiator node, which then generates a DHCPv6 reply with the delegated prefix. Again, replies are recursively sent backwards until they reach the unconfigured nodes that requested the prefixes (see Fig. 1).

Since MANET networks are dynamic in nature, it is possible that a node leaves the MANET. Due to this fact, it is desirable to avoid sending periodic messages between two specific nodes, as those from prefix lifetime renewal, within the MANET. There-

fore, all prefixes delegated within the MANET have infinity lifetimes. Of course, the MANET prefix, obtained from the access network may have - and it is likely it will - a lifetime different than infinity. If the lifetime of the MANET prefix expires, because the access network is performing a renumbering process, or because the prefix can not be renewed by the initiator, the MANET would lose the Internet connectivity since these kinds of scenarios are out of the scope of our solution. Nevertheless, renumbering is very rare in the Internet, and if the connection with the access network is lost, the MANET cannot communicate to the Internet anyway, so keeping those addresses is not such a big issue.

Due to space constraints, enhancements aimed at making the solution more robust (such as the use of *candidate* initiator nodes that, by keeping prefix information synchronised and updated, may take over the current initiator node in case of failure; mechanisms to avoid loops in the request-reply recursive process; mechanisms to reduce the signalling overhead and to take care of unused prefixes) are not described in the paper.

4 Conclusion and Future work

This paper presents a conflict-free allocation solution that, by providing prefixes instead of single addresses, enables MANET nodes to obtain a prefix that can be used for the configuration of devices attached to the node that are not part of the MANET network (i.e., that do not participate in the ad hoc routing). The solution makes use of existing standards instead of designing a new protocol from scratch. Mechanisms such as Router Advertisements and DHCPv6 are used, thus facilitating the deployment of the solution.

Simulation and/or implementation of the protocol should be performed in order to validate the solution, specially to evaluate the scalability and stability of the mechanism.

An additional topic that could be addressed in a future work is the integration of the proposed IP address autoconfiguration mechanism with protocols that deal with Internet gateway discovery in connected MANETs, since it seems logical to collocate the functionalities of initiator node and Internet gateway.

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