A Simulation–based Analysis of Algorithms for Establishing Ad hoc WLANs

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Extended summary
The last two decades have seen a significant shift in terms of the development and use of wireless communications [1,2,3]. For example, Personal Communication Systems (PCS) [4] and Wireless Local Area Networks (WLANs) [5] are common terms used in communications literature these days. These networks offer a tremendous potential for they are not bound by location or by wires. Various wireless data systems, including standards and services have been popular topics among researchers in the recent years [6]. The IEEE 802.11 Wireless Working Group [7] has also developed standards such as DFWMAC (Distributed Foundation Wireless MAC) [8] for WLANs.

An important and emerging application of wireless LANs is their use in settings such as classroom, corporate meetings, and press conferences. Existing WLANs, with or without mobile users, have a minor aura of permanency attached to them – the identity/address assigned to a user does not change frequently; a user is generally part of the single network, and the user operates in the same hardware/software environment most of the time. This aspect of current wireless LANs inhibits their use in temporary settings such as a classroom or a conference. This leads to another type of WLANs – ad hoc WLANs [9]. A typical scenario of using ad hoc wireless networks is as follows: students and instructors walk into a classroom with their laptop or palmtop computers that have wireless communication capability.

Within a short moment of the initial gathering, a temporary network of all computers in the classroom is established. The class or meeting then begins and information can be freely exchanged between the computers that are part of the temporary network. At the end of such class or meeting, the temporary associations are automatically terminated and participants walk away for another class or meeting and possibly another ad hoc wireless network.

Since any meaningful data exchange between these computers can happen only after the ad hoc network has been established, the network establishment is an important and fundamental aspect in almost all ad hoc networks. We, therefore, propose a novel mechanism to setup ad hoc networks. Three versions of the proposed mechanism for establishing an ad hoc wireless network are proposed and evaluated using simulation technique. They are named uniform, geometric, and random separately based on the nature of the probability distribution used for making decisions in each algorithm. The network setup time is the main performance parameter in this study.

We envision an ad hoc wireless local area network (WLAN) model consisting of one controller with $n$ mobile hosts operating within a limited range of communications. The controller can be a desktop or a mobile computer itself. It is capable of handling all networking functions required for establishing and managing the operations of
an *ad hoc* WLAN. All networking operations are initiated and controlled by the controller, including data transfer, routing messages in and out of the *ad hoc* WLAN. All mobile hosts are capable of communicating with the controller. However, more than one station transmitting data at any moment will result in data corrupted due to collision. The controller initiates connection termination in general. A mobile host can be dropped from the network by not responding to the controller for some period of time.

Time is divided into equal slots, each of which is good for transmitting a fixed-sized frame of some predefined structure. The controller starts the construction of an *ad hoc* network by sending out a call for the setup of a network. This process is composed of two phases: *solicitation* phase and *acknowledgement* phase. The first phase is for soliciting addresses from mobile hosts, and the second phase is for acknowledging addresses that have been received correctly by the controller. The setup process may not be considered complete until the controller has acknowledged all mobile hosts’ addresses. The total number of solicitation rounds as well as the total number of the contention slots needed for solicitation have become the major criteria in measuring the performance aspects of establishing an *ad hoc* network, since they are closely related to the total time needed for completing the network construction. We therefore focus our research on algorithms that minimize the number of solicitation rounds and contention slots needed.

It has been observed from simulation that the *uniform* algorithm has the best performance, followed by *geometric* very closely, and *random* takes the longest time in establishing a network. The number of initialization rounds needed has a unimodal distribution slightly skewed to the right for all these three different algorithms. Network setup time required can therefore be statistically estimated.

**References**


