

# Research Proposal: Performance Analysis of Ad Hoc Networks

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## Abstract

Mobile Ad Hoc Networks have attracted many research interests over the last decade. These networks are attractive because they can be easily deployed without the need of a fixed network infrastructure. Therefore, they are solutions for military operations, emergency missions, crowd controls, conferences or mining industry. Research on the performance analysis of Mobile Ad Hoc Networks (MANETs) is still limited. In this proposal, a comprehensive performance study on various aspects of ad hoc networks is proposed. The study is focused on three crucial issues, power saving scheme, connectivity and capacity study in ad hoc networks.

## 1 Literature Review and Research Motivation

It is known that the power resource in adhoc networks is extremely limited. Therefore, it is crucial to minimize this resource usage through appropriate power saving mechanisms. These mechanisms can span multiple protocol layers to achieve a more optimal result. One of the power saving schemes is reducing the transmission power. This approach not only reduces the power consumption but also increases the network capacity because it increases the capacity reuse [4]. However, limiting the transmission power means reducing the transmission range, which may seriously affect the network connectivity and hence the network performance [4] [3]. Therefore, a good power control mechanism is required to take all of these factors into account. A cross-layer optimization seems to be a natural approach for the power saving in ad hoc networks.

Connectivity is one of the most important areas in adhoc networks. Recently, it has attracted many interests. Many works adopt the results from percolation theory to investigate the network connectivity in wireless networks [5, 7, 8, 9, 11]. Though there have been some achievements through these studies, many issues remain unsolved. The impact of the interference, the mobility, the Rayleigh fading channels on the connectivity of sensor

networks, and the probability of having a strong connectivity versus weak connectivity, etc. are some of the unsolved questions.

Capacity study in adhoc networks is also an important area. The capacity study in ad hoc networks has attracted many research interests. Some recent works have shown that the transport capacity per node diminishes as the number of nodes increases to infinity [4]. This is because during each transmission, a given mobile node “consumes” a certain “footprint”, where no other transmission is possible. This limitation affects all wireless networks using CSMA/CA. Motivated by this significant work, Grossglauser proved that by employing the mobility of the mobile nodes, and using relay transmission, the network transport capacity can be improved significantly [2]. However, this is achieved with the cost of a significantly high packet delay due to packet buffering at the relayed nodes. In [10], Toupis and Goldsmith described the transporting capacity of the network in terms of an  $n(n - 1)$ -dimensional region and derived the boundary of the capacity region. They also studied the impact of power control, queueing mechanism, and routing protocols on the capacity of ad hoc networks. Furthermore, they proposed two MAC protocols which were shown to outperform the conventional MAC protocols. Nevertheless, so far there has been no significant breakthrough in improving the ad hoc network capacity. In my opinion, CDMA altogether with latest multi-user detection technology seem to be an attractive solution for increasing the capacity of ad hoc and sensor networks as shown in some preliminary works by Tong [6, 1].

## 2 Research Outcome

As discussed in the previous section, the research project is aimed to achieve the following three objectives

- Firstly, it is expected to produce an in-depth study of the power consumption in ad hoc networks. Using this knowledge, an innovative power saving scheme is derived.
- Secondly, an intensive study of connectivity in ad hoc networks is carried out. As a result, it can derive the optimal transmission range for mobile nodes in a network. Furthermore, it also can provide understanding on the effect of the mobility, signal interference on the network connectivity.
- Thirdly, an comprehensive study of the fundamental limitation of CSMA/CA in terms of transport capacity is produced. In addition, it gives solution on how CDMA and multiuser detection can be employed to increase the performance of ad hoc networks. Ultimately, the study can result in a new Medium Access Control (MAC) protocol

using CDMA as well as the multiuser detection which can outperform the conventional TDMA or CSMA/CA-based MAC protocols such as HiperLan or IEEE 802.11

### **3 Research Approach**

The research project will be carried out in a top-down approach. Initially, an intensive literature survey of the three main research areas is carried out. This survey provides the most up-to-date knowledge on these areas. This knowledge is subsequently used to derive solutions for the power control mechanism, connectivity and capacity in ad hoc networks.

The solutions are subsequently analysed through a analytical study using appropriate mathematical models, or a numerical study through MATLAB or MAPLE. The theoretical results are then verified through intensive simulation using NS2.

The results are obtained and recorded in each stage through technical reports. Furthermore, they may also be published through journals or conference paper.

Due to the scale of the project, it is important to ensure that all the data is backed up and stored using a proper configuration management.

### **4 Work Plan and Budget and Resource Requirement**

On average, it is required one year full-time work on each research areas. Therefore, the proposed duration for the project is initially set at three years. However, this duration may vary subjected to the requirements and budget availability.

The resource requirement consists of one “fast” computer with following installed softwares, MATLAB, NS2, MAPLE, CVS, Latex, Web-browser. It is preferred that the computer is Unix/Linux-based and connected to other computers for facilitate the simulation.

### **5 Commercialisation Prospect**

Since the research study is focused on the most cutting-edge areas in ad hoc networks. Furthermore, it addresses the major fundamental limitations of ad hoc networks. Therefore, it is expected that the study is well sought after by the industry. Some of the major players include (but are not limited to) Defence Science Technology Organization, Motorola and Cisco.

## References

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